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ULLETIN OF THE IMPERIAL INSTITUTE

A QUARTERLY RECORD OF PROGRESS IN TROPICAL AGRICULTURE AND INDUSTRIES AND THE COMMERCIAL UTILISATION OF THE NATURAL RESOURCES OF THE COLONIES AND INDIA

EDITED BY THE DIRECTOR AND PREPARED BY THE SCIENTIFIC AND TECHNICAL STAFF OF THE IMPERIAL INSTITUTE AND BY OTHER CONTRIBUTORS

VOL. XI NO. 1 JANUARY–MARCH 1913

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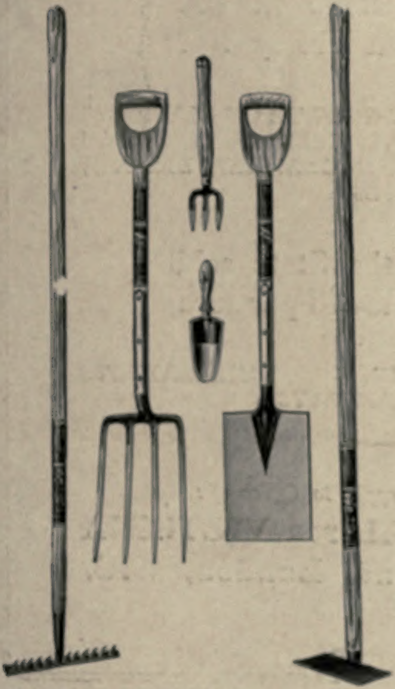

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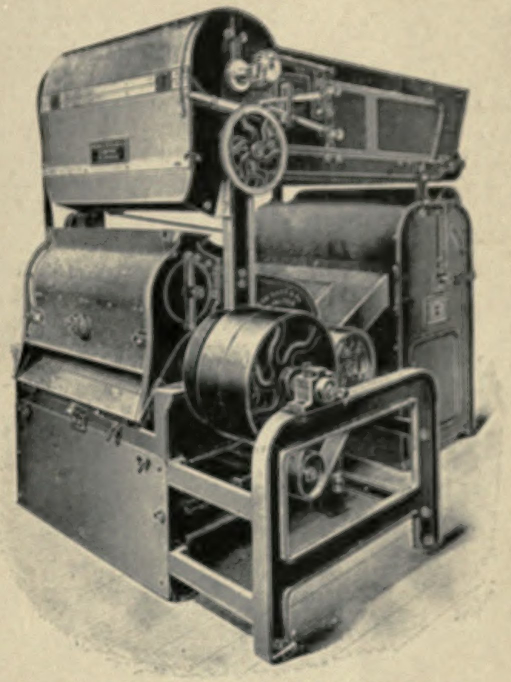

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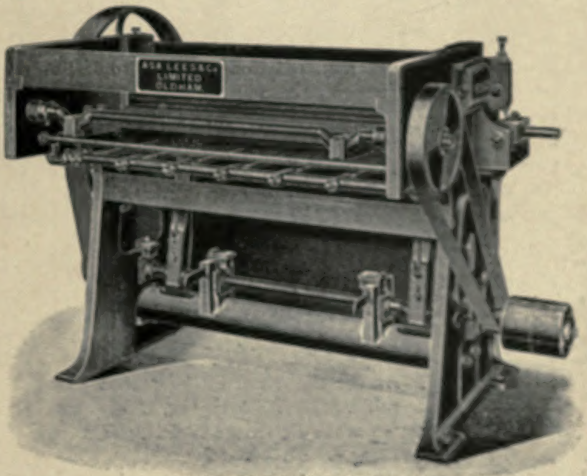

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CONTENTS

VOL. XI NO. 1

INTRODUCTORY STATEMENT

PAGE
THE IMPERIAL INSTITUTE 1

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

TOBACCOS FROM PORTUGUESE EAST AFRICA 11
TOBACCO FROM PAPUA 31
THE UTILISATION OF SUDAN DURA 33
CAMPHOR OIL AND CRUDE CAMPHOR FROM THE FEDERATED MALAY STATES 46
OIL OF *EUCALYPTUS CITRIODORA* FROM MAURITIUS . 48
MARJORAM OIL FROM CYPRUS 50
BEESWAX FROM THE ANGLO-EGYPTIAN SUDAN . . . 53
OIL-SEEDS FROM THE ANGLO-EGYPTIAN SUDAN . . 56
"CHEYI" SEED AND FIBRE 62
ZAPUPE FIBRE 65
"CABBAGE TREE" FIBRE FROM NEW ZEALAND . . . 67
"ELEPHANT GRASS" AS A PAPER-MAKING MATERIAL . 68
THE COTTON INDUSTRY OF NORTHERN NIGERIA . . 70
SOME FLOSSES OR SILK-COTTONS 79
M'ZIMBITI TIMBER FROM MOZAMBIQUE 83
TIMBER OF *TRIPLOCHITON JOHNSONII* 84
CRUDE PETROLEUM FROM MOROCCO 85
PETROL FROM TASMANIA 87
CRUDE PETROLEUM FROM NOVA SCOTIA 89

SPECIAL ARTICLES

THE PROGRESS OF EGYPTIAN AGRICULTURE, WITH SPECIAL REFERENCE TO COTTON 90
By GERALD C. DUDGEON, F.E.S., Director-General of the Department of Agriculture in Egypt, Vice-President of the International Association for Tropical Agriculture.
THE AGRICULTURE OF MOZAMBIQUE PROVINCE, PORTUGUESE EAST AFRICA 102
By R. N. LYNE, F.L.S., Director of Agriculture, Ceylon; lately Director of Agriculture in the Province of Mozambique.
THE POTTERY INDUSTRY OF ILORIN, NORTHERN NIGERIA 110
By DR. J. W. SCOTT MACFIE, Medical Officer, Ilorin, Northern Nigeria.

GENERAL NOTICES RESPECTING ECONOMIC PRODUCTS AND THEIR DEVELOPMENT

SOME COMMON SPICES 121
MANUFACTURE OF PAPER PULP FOR EXPORT . . . 136

GENERAL NOTES

SISAL HEMP CULTIVATION IN GERMAN EAST AFRICA . 141
RECENT DEVELOPMENTS IN COTTON GROWING IN THE UNITED STATES 142
COCOA FROM SOUTHERN NIGERIA 144
THE AGRICULTURAL POSSIBILITIES OF THE PANAMA CANAL ZONE 144
MINERAL OUTPUT OF NEW SOUTH WALES 145
MINERAL OUTPUT OF QUEENSLAND 146
THE UTILISATION OF ZIRCONIUM MINERALS . . . 147
ASH OF *CYPERUS HASPAN* 148
RECENT PROGRESS IN AGRICULTURE AND THE DEVELOPMENT OF NATURAL RESOURCES 149

NOTICES OF RECENT LITERATURE

NEW BOOKS 177

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THE Imperial Institute was erected at South Kensington as the National Memorial of the Jubilee of Queen Victoria, by whom it was opened in May 1893.

The principal object of the Institute is to promote the utilisation of the commercial and industrial resources of the Empire by arranging comprehensive exhibitions of natural products, especially of the Colonies and India, and providing for their investigation, and for the collection and dissemination of scientific, technical, and commercial information relating to them.

Until the end of 1902 the Imperial Institute was managed by a Governing Body, of which H.R.H. the Prince of Wales (afterwards King Edward VII.) was President, and an Executive Council, including representatives of the Indian Empire and of all the British Colonies and Dependencies. In 1900 the building became the property of H.M. Government, by whom the western portion and galleries were leased to the Governing Body of the Imperial Institute, the greater part of the eastern and central portions being assigned, subject to certain rights of usage by the Imperial Institute, for occupation by the University of London. In July 1902 an Act of Parliament was passed transferring the management of the Imperial Institute to the Board of Trade, assisted by an Advisory Committee including representatives of the Dominions, Colonies, and India, as well as of the Colonial and India Offices, the Board of Agriculture, and the Board of Trade. This Act took effect on January 1, 1903.

On October 1, 1907, in virtue of an arrangement made with the Board of Trade and with the approval of the Secretary of State for India, the management of the Imperial Institute was transferred to the Secretary of State for the Colonies, subject to the responsibility of the Board of Trade under the Act of 1902. A Committee of Management of three members, one nominated by each of the three Government Departments chiefly concerned, has been appointed, and at present consists of Mr. C. A. Harris, C.B., C.M.G.; Sir Alfred Bateman, K.C.M.G.; and Colonel D. G. Pitcher (late Indian Army).

The first Director of the Imperial Institute was Sir Frederick Augustus Abel, Bart., G.C.V.O., K.C.B., F.R.S., who held the office until his death in the autumn of 1902. The present Director is Professor Wyndham Dunstan, C.M.G., M.A., LL.D., F.R.S., who was appointed in 1903.

The staff of the Imperial Institute includes officers with special qualifications in the sciences of chemistry, botany, geology, mineralogy, and in certain branches of technology, in their relation to agriculture and to the commercial utilisation of economic products.

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A Central Stand for Publications and an Enquiry Office have been opened in the centre of the main gallery to facilitate the supply of general information and the distribution of literature. Handbooks, pamphlets, circulars, etc., containing information relating to the commerce, agriculture, mining, and other industries of the principal British Colonies, and also to emigration, are available for gratuitous distribution or for sale. The publications of the Emigrants' Information Office, established by the Colonial Office, may also be obtained. Lists of the publications available for distribution or sale are provided, and the principal Colonial and Indian newspapers may be seen on application. An officer of the Institute is in attendance at this stand, which is in telephonic communication with the Departments in the main building.

In 1912 the public galleries were visited by 205,503 persons, and 17,595 Colonial and Indian publications were distributed.

Scientific and Technical Department.—The research laboratories of this Department, which occupy the second floor of the Imperial Institute, were established in order to provide for the investigation of new or little-known natural products from the Colonies and India and of known products from new sources, with a view to their utilisation in commerce, and also to provide trustworthy scientific and technical advice on matters connected with the agriculture, trade, and industries of the Colonies and India.

The work of this Department is chiefly initiated by the Home and Colonial Governments and the Government of India. Arrangements have been also made by the Foreign Office, whereby British representatives abroad may transmit to the Department for investigation such natural products of the countries to which they are appointed as are likely to be of interest to British manufacturers and merchants.

Materials are first investigated in the research laboratories of the Department, and are afterwards submitted to further technical trials by manufacturers and other experts, and finally are commercially valued.

A Reference Sample Room is maintained in this Department, in which are arranged samples of the principal materials which have been investigated and valued commercially during recent years, and as to which full information is available.

The Scientific and Technical Department works in cooperation with the Agricultural and Mines Departments in the Colonies, whose operations it supplements by undertaking such investigations as are of a special scientific or technical character connected with agricultural or mineral development, as well as enquiries relating to the composition and commercial value of products (animal, vegetable, or mineral) which can be more efficiently conducted at home in communication with merchants and manufacturers, with a view to the local utilisation of these products or to their export.

A very large number of reports on these subjects have been made to the Governments of the Colonies and India, a first instalment of which was printed in a volume of *Technical Reports and Scientific Papers*, published in 1903. A series of Selected Reports is now being issued in the Miscellaneous Series of Colonial Reports. Of these Selected Reports, four have been published: Part I. "Fibres" (Cd. 4588), Part II. "Gums and Resins" (Cd. 4971), Part III. "Foodstuffs" (Cd. 5137), Part IV. "Rubber and Gutta Percha" (Cd. 6022), whilst others are in preparation.

Mineral surveys, under the supervision of the Director of the Imperial Institute, and conducted by Surveyors selected by him, are in progress in several countries. All minerals found which are likely to be of commercial importance are forwarded to the Imperial Institute, where they are examined and their composition and commercial value ascertained. Reports by the Director on the results of mineral exploration in Ceylon, Northern Nigeria, Southern Nigeria, and Nyasaland have been printed in the Miscellaneous Series of Colonial Reports.

African Tropical Service Course.—A course of instruction in certain specified subjects is now given at the Imperial Institute to candidates selected by the Colonial Office for administrative appointments in East and West Africa. Instruction in the subject of tropical cultivation and products in this course is given by members of the Staff of the Imperial Institute.

Library and Reading-Rooms.—The library and reading-rooms of the Imperial Institute contain a large collection of Colonial and Indian works of reference, and are regularly supplied with the more important official publications, and with many of the principal newspapers and periodicals of the United Kingdom, the Dominions, the Colonies, and India.

The library and reading-rooms are on the first floor, and admittance to them is obtained through the entrance at the west (Queen's Gate) end of the building. These rooms are available for the use of Life Fellows of the Imperial Institute, and of other persons properly introduced. Books and newspapers may be consulted for special purposes by permission.

Colonial Conference Rooms.—Three rooms, specially decorated and furnished, are reserved on the principal floor for use by representatives of the Colonies for meetings and receptions.

The Cowasjee Jehanghier Hall.—The Bhownagree corridor and rooms in connection with this hall are in the occupation of the Indian Section of the Imperial Institute, whilst the hall is available for lectures, meetings, etc.

The "Bulletin of the Imperial Institute" is published quarterly by Mr. John Murray, 50A, Albemarle Street, London, price *2s. 6d.* (annual subscription 11*s.*, including postage), and may be purchased through any bookseller or from agents in the Colonies and India. The BULLETIN contains records of the principal investigations conducted for the Colonies and India at the Imperial Institute, and special articles chiefly relating to progress in tropical agriculture and the industrial utilisation of raw materials (animal, vegetable, and mineral).

Imperial Institute Handbooks on Tropical Resources.—The Secretary of State for the Colonies has authorised the preparation of a series of handbooks dealing with the Commercial Resources of the Tropics, with special reference to West Africa. The handbooks are edited by the Director of the Imperial Institute, and published by Mr. John Murray, price 5*s.* net each. The first two volumes are: *The Agricultural and Forest Products of British West Africa*, by Gerald C. Dudgeon, Director-General of Agriculture in Egypt, and lately Inspector of Agriculture for British West Africa; and *Cocoa*: *Its Cultivation and Preparation*, by W. H. Johnson, F.L.S., Director of Agriculture in Southern Nigeria. The third volume, entitled *Rubber, its Sources, Cultivation, and Preparation*, by Harold Brown, Technical Superintendent, Scientific and Technical Department, Imperial Institute, is now in the press.

The following Societies have their offices at the Imperial Institute:

International Association for Tropical Agriculture, British Section.—The object of this Association, the Central Bureau of which is in Paris, is the promotion of the scientific and practical study of all questions connected with tropical agriculture and the development and utilisation of natural resources, especially of tropical countries. The British Section has its headquarters at the Imperial Institute. Members of the British Section are permitted to use the library and reading-rooms of the Imperial Institute, and a writing-room has been also provided for their use.

British Women's Emigration Association.—The British Women's Emigration Association has been assigned offices on the mezzanine floor, which are open daily from 10 a.m. to 4 p.m. Advice and information respecting emigration and prospects for women in the Colonies may be obtained there free of charge. This Association works in co-operation with the Emigrants' Information Office in Westminster.

Colonial Nursing Association.—An office has been allotted on the mezzanine floor to this Association. The principal object of the Association is the selection of trained hospital and private nurses for service in the Crown Colonies and Dependencies.

Tropical Diseases Bureau.—Temporary office accommodation on the mezzanine floor has been provided for this Bureau, the main purpose of which is to collect information regarding tropical diseases and to distribute it as widely as possible among those who are engaged in combating such diseases.

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REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

The following summaries have been prepared from a selection of the Reports made by the Director of the Imperial Institute to the Colonial, Indian, and other Governments concerned.

TOBACCOS FROM PORTUGUESE EAST AFRICA

UNTIL a few years ago the production of "bright" tobacco, the variety which is used in the manufacture of most of the pipe and Virginian cigarette tobaccos made in the United Kingdom, was confined to the southern portion of the United States. Now, however, the cultivation of this kind of tobacco has become firmly established in Nyasaland and Rhodesia, both of which countries export it to the United Kingdom. In other parts of south and south-eastern Africa very promising results have also been obtained with this kind of tobacco, notably in the Transvaal and Cape Province, and in the last few years interesting experiments with it have been made in the Territories of the Mozambique Company in Portuguese East Africa. Since 1909 a number of samples of tobacco have been received at the Imperial Institute from the London office of the Mozambique Company for examination, and a summary of the results obtained in this work is now given. These Mozambique tobaccos are of great interest in two ways. In the first place they confirm the experience already obtained in Nyasaland and Rhodesia that tobacco possessing the chief characteristics of "bright Virginia tobacco" can be produced outside the tobacco districts of the United States, and that such tobacco is readily saleable in this country. This is a matter of great importance, since it means that although the flavour and aroma of the "smoke" yielded by these African tobaccos are slightly different from those furnished by the corresponding American products, these differences are either too slight to be perceptible to the average smoker, or are of a kind that suits his taste. The evidence available indicates that the latter is the case, since blends of African tobaccos have lately appeared on the market. The second point of interest in connection with these Mozambique tobaccos is that in the first series of experiments a great variety of tobacco seed was used, including that of typical "Virginian," cigar, and Levantine tobaccos. The produce was, however, all prepared by the methods adopted in curing typical Virginian tobaccos, and, curiously enough, though the leaves, as regards shape and size, retained the characteristics of the types from which they were derived, they all "smoked" more or less like Virginian tobaccos. The importance of this point lies in the fact that tobacco has been regarded hitherto as an almost mysteriously variable crop. It is well known, for example, that if tobacco is grown in a new country from Sumatra seed, care being taken to follow Sumatra methods of cultivation and preparation, the produce as a rule develops characteristics of its own, which clearly differentiate it from the type which served as its parent. In practice this means that every country which embarks on tobacco cultivation has to face the difficulty of popularising a new kind of tobacco. These African experiments, and especially those conducted in Mozambique, seem to show, however, that the factors which determine the variability of tobacco can be ascertained, and if they can once be determined, it should not be impossible to control them, at least to some extent. Such problems can only be solved by experimental work on the plantation and in the laboratory.

EXAMINATION OF SAMPLES

FIRST SERIES (1909)

No. 1. *Zimmer's Spanish.*—The sample consisted chiefly of medium-sized leaves of "semi-bright" Virginia type, but contained also many leaves which would be classed as "mahogany." The leaves were of coarse texture, and measured from 11 to 19 in. in length by 4 to 8½ in. in breadth.

The tobacco was of fair burning quality, but the combustion was irregular. The ash was black.

No. 2. *Long-leaf Gooch.*—Virginia tobacco, of even, dark brown colour, and fairly free from blemishes. The leaves varied in size from 16 by 7½ in. to 13 by 5½ in.

The tobacco held fire fairly well, and left a dark grey ash.

No. 3. *Conqueror.*—Dark Virginia tobacco, in good condition, and of fairly uniform nut-brown colour, with occasional green patches. The leaves measured from 13 by 5½ in. to 17 by 7½ in.

The sample was of fair burning quality, much resembling No. 2 in this respect, and left a dark grey ash.

No. 4. *Connecticut Seed Leaf.*—This consisted of leaves of "dark" Virginia type, but was very mixed, and in colour varied from "semi-bright" to "mahogany" and "dark." Many of the leaves showed green patches. The dimensions of the leaves varied from 11 by 3½ in. to 19 by 9 in.

The tobacco burnt fairly well, leaving a grey ash.

No. 5. *Sumatra.*—The sample, which was rather broken, consisted of leaves of "mahogany" tobacco, more even in colour than the preceding sample; but it was probably intended for a "bright" tobacco, and subsequently fermented, as there were many bright leaves, and the brown patches were of irregular distribution. The leaves varied in size from 9 by 4 in. to 13½ by 7 in.

The tobacco held fire only moderately well, and left a black ash.

No. 6. *Yellow Mammoth.*—The sample consisted for the most part of dull "mahogany" tobacco, but also contained "semi-bright" and "dark" leaves. The dimensions of the leaves in the sample varied from 16½ by 5½ in. to 19 by 9 in.

The tobacco burnt only moderately well, and left a black ash.

No. 7. *Lacks.*—This tobacco was in fair condition, and consisted of rather dark "mahogany" leaves with a general greenish tinge. The leaves varied from 11 to 17 in. in length, and from 4 to 8½ in. in breadth.

The tobacco held fire only moderately well, and left a black ash.

No. 8. *Florida Sumatra.*—This sample consisted of leaves varying in colour from "dark" to dark "mahogany." Most of them were rather broken and somewhat streaky. In size the leaves varied from 10 by 4¾ in. to 17 by 8½ in.

The tobacco was of poor burning quality, and inferior to the preceding samples in this respect. The ash was black.

No. 9. *Vuelta Abajo.*—The sample consisted of leaves of fairly fine texture, mottled, and mostly of a greenish shade. The midribs and veins were rather heavily marked. In size the leaves varied from 8 by 3¼ in. to 11½ by 6 in.

The tobacco held fire badly, and left a black ash.

No. 10. *Sumatra.*—The sample, which was in fair condition, consisted of "mahogany" leaves, somewhat unevenly shaded, with occasional dark streaks. The leaves measured from 10½ to 16 in. in length and from 5 to 9 in. in breadth.

The tobacco had fairly good burning qualities, and left a grey ash.

No. 11. *Cuban Leaf.*—The sample consisted of leaves of cigar type as regards size and shape, but had been prepared as a "pipe" tobacco. The leaves, which were in a rather broken condition, varied in colour from even nut-brown to well-marked "mahogany," and in dimensions from 8 by 2½ in. to 14 by 7 in.

The tobacco burnt and held fire fairly well, but the combustion was irregular.

No. 12. *Sweet Orinoco.*—"Mahogany" tobacco in fairly good condition, plentifully mixed with "semi-bright" leaves slightly marked with brown. The leaves in the sample varied from 13½ to 18 in. in length and from 5¼ to 8 in. in breadth.

The tobacco burnt fairly well, leaving a black ash.

No. 13. *Sumatra.*—"Mahogany" tobacco, including some very good leaves. The dimensions of the leaves in this sample varied from 14 by 6 in. to 16 by 8 in.

The tobacco held fire very well, but the combustion was irregular. The ash was dark grey.

No. 14. *Honduras.*—The sample consisted of leaves varying from dark "mahogany" to very "dark" in colour and tinged somewhat with green. The texture was rather coarse. The leaves were of fairly uniform size, varying from 10 by 4½ in. to 14 by 7½ in.

The tobacco burnt poorly, leaving a black ash.

No. 15. *Eastern Pride.*—"Mahogany" tobacco, with many rather darker leaves. The sample was somewhat gritty, owing to sand on the leaves. Occasional green spots were noticed. The dimensions of the leaves were from 11½ by 5½ in. to 16 by 9½ in.

The tobacco held fire fairly well, leaving a light grey ash.

No. 16. *Kentucky Yellow.*—The sample, which was in fair condition, consisted of leaves varying in colour from "semi-bright" to "mahogany" and "dark." The leaves were very mixed as regards size, and varied from 13 by 6¼ in. to 17 by 8½ in.

The tobacco was fair to moderate in burning qualities. The ash was dark.

No. 17. *Smyrna.*—The sample consisted of leaves varying in colour from medium to dark brown. Many of the darker leaves were of an even nut-brown shade. The leaves were small, and on the whole fairly uniform in size; the extreme dimensions were 5½ by 3¼ in. and 10 by 5 in.

The tobacco had good burning qualities, except for the dark leaves, which held fire badly.

No. 18. *Goldfinder.*—The sample consisted of "mahogany" leaves, in fair condition, and with few actual blemishes, but varying considerably in size. The extreme dimensions were 11½ by 3½ in. and 17 by 8 in.

The tobacco was of rather poor burning quality, and held fire badly.

No. 19. *Warne.*—Rather coarse tobacco, varying in shade from dark "mahogany" to "dark." The leaves were badly prepared, and showed many spots, blotches, and tears. The dimensions of the leaves varied from 9½ by 4 in. to 16½ by 8½ in.

The tobacco held fire only moderately well, and the combustion was very irregular.

No. 20. *White Stem Orinoco.*—The sample consisted of rather broken "mahogany" leaves, with occasional "bright" and some "dark" leaves. The tobacco was somewhat gritty, owing to sand. The leaves were very mixed in size, and varied from 9 by 3 in. to 15 by 7½ in.

The burning quality of the tobacco was only fair, and the combustion was irregular.

Samples 1, 4, 9, 10, and 17 were analysed, with the following results:

Numbers of sample	1	4	9	10	17	
					Dark leaves.	Light leaves.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Moisture . . .	13·6	10·2	9·0	11·8	12·6	9·3
Nicotine . . .	1·9	4·1	2·4	3·4	2·3	1·5
Total nitrogen . .	1·5	2·6	1·4	2·0	1·6	1·8
Ash	10·6	8·7	8·0	7·3	6·4	8·8
The ash contained:						
Lime CaO	15·1	19·8	26·8	35·0	27·7	28·7
Magnesia MgO	13·2	10·6	11·5	13·2	14·8	15·0
Potash K_2O	23·8	17·4	12·5	15·5	15·7	18·8
Sulphuric acid SO_3	6·3	3·5	5·5	4·2	8·3	6·6
Chlorine Cl	6·9	0·7	1·1	0·7	4·1	4·2

The tobaccos were submitted to manufacturers, who valued them as follows as pipe tobaccos:

Nos. 3, 6, 12, 15: 8*d.* per lb.

" 16, 18, 19, 20: 6*d.* per lb.

" 1, 2, 4, 5, 7, 8, 9, 10, 11, 13, 14: 5¼*d.* to 6½*d.* per lb.

Sample No. 17 was grown from seed of Levantine type, but, as already stated, was prepared as a Virginian tobacco. It was submitted for valuation to manufacturers using Levantine tobacco, who stated that it had lost the characters of Levantine tobacco and had developed those of Virginian tobacco.

Generally speaking, the present samples may be regarded as very satisfactory for a first attempt at tobacco cultivation in a new locality, since they could all be sold as pipe tobaccos in the United Kingdom. The principal faults (apart from those due, as mentioned below, to inappropriate cultivation and preparation) are the rather poor burning quality of the samples and the dark colour of the ash. The analyses of the ash show that these faults are due to insufficiency of potash and excessive amounts of sulphates and chlorides.

In spite of the fact that these tobaccos do not burn well, as a whole, their flavour and aroma are described by experts as very fair. These features, however, would be enhanced if the burning quality were improved. The faults characterising the combustion in the present samples can be remedied by the use of manure rich in potash. This is best applied in the form of plant ashes, and the use of potassium chloride and potassium sulphate for this purpose should be avoided.

Types of Tobaccos

As already mentioned commercial tobaccos may be roughly grouped into three main classes, viz. cigar types, Virginian types used for smoking mixtures, and small-leaved Levantine tobaccos. Each of these requires different methods of cultivation and preparation.

In the present collection of samples all three types of tobacco were represented, Nos. 4, 5, 8, 9, and 10, for example, being grown from cigar-leaf seed, and Nos. 3, 6, 12, 15, 16, and others from Virginian-leaf seed, whilst No. 17 was obtained from Levantine-leaf seed. All the samples, however, were grown and cured under "bright" tobacco conditions, so that all had the texture and appearance of pipe tobaccos and were suitable for use in the preparation of smoking mixtures.

Future Experiments

It is clear, from the results of the examination of these samples, that pipe tobaccos of good quality can be grown in the M'Zimbiti district. Of the samples examined, the most promising materials for pipe tobaccos were Nos. 3, 6, 12, 15, 16, 18, 19, and 20. It might be well in future trials to confine attention to about four of these, say Nos. 3, 6, 12, and 15, though in selecting a limited number of kinds for trial, regard should also be had to the yield obtained from each kind. The varieties selected should be cultivated by the methods in vogue for pipe tobaccos. In curing the tobacco, an attempt should be made to produce "bright" and "semi-bright" tobaccos, since these are more valuable, as a rule, in the United Kingdom than the "mahogany" and "dark" types, which are prevalent in the samples now reported on.

Insect Pests

It should be noted that some of the present samples of tobacco were infected with "tobacco beetle," and had to be disinfected before they could be submitted to experts. The insect in question, which was probably introduced in this instance with the seed, affects stored tobacco, and has caused much trouble in the United States and elsewhere.

To prevent the development of this pest in future consignments, the curing barn and the warehouse in which the tobacco is to be stored should be thoroughly disinfected with carbon disulphide. For this purpose the barn and warehouse should be closed and made as airtight as possible, and open vessels containing carbon disulphide should be placed in them and left for twenty-four hours. The disinfectant should be used in the proportion of 1 lb. to 1,000 cubic feet of space. Carbon disulphide vapour is poisonous, and when mixed with air is highly inflammable and explosive. The disinfection should therefore be carried out under European supervision, and the greatest care should be taken that no light is brought near the buildings whilst disinfection is in progress, or until the whole of the disinfectant vapours have been dissipated. After the buildings have been treated with the disinfectant, all doors and windows should be opened wide and left so for at least twenty-four hours, or until the odour of carbon disulphide is no longer perceptible.

Considerable risk of loss attends any attempt to treat tobacco itself with insecticides, and it is better to avoid any risk of its being attacked by "tobacco beetle" by scrupulous care and cleanliness in the barns and warehouses.

Grading and Packing of Tobacco

In preparing experimental samples, such as those dealt with in the present report, grading is of little moment; but it should be noted that, in the preparation of commercial tobacco for export, it is most important that leaves of about the same size and colour should be kept together. It is only by proper attention to grading of this kind, and to the elimination of discoloured or stained leaves, that the best prices can be obtained. The inclusion of variously coloured or stained leaves in a "hand," or a consignment, involves lower prices being obtained for the whole. As a rule, twenty to twenty-five leaves should be packed in each "hand," which should be tied at the base with a leaf of its own class.

It is also most important that tobacco should be packed neither too dry nor too damp. In many of the bundles now under report the inside leaves had been packed too damp, and had fermented during transit, becoming in this way much darker than the rest of the bundle. Generally, tobacco containing 11 to 12 per cent. of moisture at the time of packing carries well and does not become discoloured on storage.

SECOND SERIES (1910)

FLUE-CURED VIRGINIAN TOBACCOS

These consisted wholly of tobaccos grown from seed of Virginian types of tobacco, and all were grown and cured on the lines usually adopted for such tobaccos.

No. 1. *Kentucky Yellow.*—Seed imported from Nyasaland 1910. Grown on virgin land.

The leaves varied in size from 6 by 13 in. to 9½ by 19 in. They were mostly "mahogany" in colour, a few being pale dull brown and a few "bright." Most of the leaves showed a few "burns."

The sample burnt fairly easily in cigarette form. The ash cohered well and was grey in colour.

No. 2. *Raglan's Conqueror.*—Origin and cultivation same as No. 1.

The leaves varied in size from 8½ by 17 in. to 11 by 22 in., but were mostly of the larger sizes. They were generally of typical "mahogany" colour, with a few "bright" leaves. A few of the leaves showed "burns."

The sample burnt well in cigarette form. The colour of the ash was light grey.

No. 3. *Conqueror.*—Seed imported from Rhodesia 1908; since grown and selected at M'Zimbiti. Land, 1910 season, manured with green crop cow-peas and cotton-seed; previous year unmanured.

The leaves varied from 7½ by 18 in. to 11 by 21 in., but were mostly of the larger sizes. They were almost entirely of rather dark "mahogany" colour. A few of the leaves showed "burns."

The sample burnt well in cigarette form. The ash cohered well and was dark grey in colour.

No. 4. *Goldfinder.*—Origin of seed and cultivation same as No. 3.

The leaves varied from 7½ by 18 in. to 9 by 21 in., but were mostly of the larger sizes. They were generally of a dull, rather dark "mahogany" colour. Most of the leaves showed a few "burns."

The sample burnt fairly well in cigarette form. The ash cohered well and was light grey in colour.

No. 5. *Gooch.*—Seed imported from Transvaal 1909; since grown from seed selected at M'Zimbiti. Land, 1910 season, manured with green crop of cow-peas and cotton-seed; previous year unmanured.

The leaves varied in size from 7½ by 16 in. to 8 by 18 in., and were of rather dull "mahogany" colour. Nearly all the leaves showed one or more "burns."

The sample burnt well in cigarette form. The ash cohered fairly well, but was flaky; it was of grey colour.

No. 6. *Lacks.*—Seed imported from Rhodesia 1908; since grown and selected at M'Zimbiti. Grown on two plots 1910, one manured with green crop cow-peas, one with cotton-seed; produce of two plots mixed; previous year unmanured.

The leaves varied in size from 6½ by 15 in. to 11 by 20 in., and were rather bright "mahogany" in colour. Many of the leaves showed numerous "burns."

The sample burnt fairly well in cigarette form. The ash cohered fairly well and was of grey colour.

No. 7. *White Burley.*—Seed imported from United States 1909; present crop grown from seed selected from M'Zimbiti 1909 crop. Land, 1910 season, manured with green crop cow-peas and cotton-seed. Previous year not manured.

The leaves were fairly uniform in size, the average being 8 by 21 in. They were bright orange-brown in colour, with occasional darker and "mahogany" shades.

The sample burnt fairly well in cigarette form. The ash cohered well and was dark grey in colour.

No. 8. *Yellow Mammoth.*—Seed imported from Transvaal 1908; since grown from seed selected at M'Zimbiti. Land, 1910 season, manured with green crop cow-peas and cotton-seed. Previous year unmanured.

The leaves were fairly uniform in size, the average being 7 by 20 in. They were mostly "semi-bright" in colour. A few showed "burns."

The sample burnt well in cigarette form. The ash cohered well and was grey in colour.

No. 9. *Long-leaf Gooch.*—Origin and cultivation same as No. 8.

The leaves were fairly uniform in size, the average being 8½ by 19 in. They varied in colour from dull yellowish-brown to dull "mahogany." A few of the leaves showed "burns."

The sample burnt well in cigarette form. The ash cohered well and was grey in colour.

No. 10. *Eastern Pride.*—Origin of seed and cultivation same as No. 8.

The leaves varied in size from 7 by 15 in. to 10 by 21 in. In colour they ranged from bright "mahogany" to dull brown, but were mostly dark "mahogany." Most of the leaves showed one or more "burns."

The sample burnt fairly well in cigarette form. The ash cohered well, and was grey in colour, with black patches.

No. 11. *Kentucky Yellow.*—Origin of seed and cultivation same as No. 8.

The leaves varied in size from 6 by 15 in. to 9 by 20 in. They showed variation in colour from bright orange-brown to rather dull "mahogany." Most of the leaves showed a few "burns."

The sample burnt fairly well in cigarette form. The ash cohered well, but was irregular in colour, being mostly light grey with darker patches.

No. 12. *Coolie Hybrid.*—Seed imported from United States 1909. Grown on land manured with green crop of cow-peas only.

The leaves varied in size from 7 by 15 in. to 11 by 21 in. They varied in colour from dull yellow to dark "mahogany," but were mostly bright "mahogany." Most of the leaves showed one or two "burns."

The sample burnt fairly well in cigarette form. The ash cohered well and was light grey in colour.

No. 13. *Maryland Smoking.*—Origin of seed and cultivation same as No. 12.

The leaves were fairly uniform in size, the average being 5½ by 19 in. They were mostly "mahogany" in colour. A few of the leaves showed "burns."

The sample burnt fairly well in cigarette form. The ash cohered fairly well, and in colour was light grey but black at the edges.

No. 14. *Virginia Orinoco.*—Origin of seed and cultivation same as No. 12.

The leaves were fairly uniform in size, the average being 6 by 20 in. They were mostly dull "mahogany" in colour. All the leaves showed one or two "burns."

The sample burnt fairly easily in cigarette form. The ash cohered well and was light grey in colour.

No. 15. *Brewer Hybrid.*—Origin of seed and cultivation same as No. 12.

The leaves were fairly uniform in size, the average being 7½ by 15 in. They were bright orange-brown in colour. Most of the leaves showed "burns."

The sample burnt fairly well in cigarette form. The ash cohered well and was grey in colour.

No. 16. *Hester.*—Seed imported from Rhodesia 1908. Grown on land manured with cow-peas only.

The average size of the leaves was 10 by 20 in., a small proportion being long and narrow. They were mostly bright "mahogany" in colour. All the leaves showed one or more "burns."

The sample burnt fairly well in cigarette form. The ash cohered well, and was in colour mainly light grey, but partly black.

No. 17. *White Stem.*—Origin of seed and cultivation same as No. 12.

The leaves were fairly uniform in size, the average being 7½ by 20 in. They were bright orange-brown to dull "mahogany" in colour. Most of the leaves showed one or two "burns."

The sample burnt fairly well in cigarette form. The ash was nearly white.

No. 18. *Bullion.*—Seed imported from Rhodesia 1908. Grown on land 1910, manured with cow-peas only.

The leaves varied in size from 4 by 15 in. to 7 by 22 in. They were mostly "mahogany" in colour. All the leaves showed one or more "burns."

The sample burnt fairly easily. The ash cohered fairly well, and varied in colour from light to dark grey.

No. 19. *Sweet Orinoco.*—Seed imported from United States 1908. Grown on land manured with cow-peas only.

The leaves were fairly uniform in size, the average being 8 by 22 in. They were mostly of a "mahogany" colour, a few being yellow. Most of the leaves showed a few "burns."

The sample burnt well in cigarette form, leaving an almost white ash.

Samples 1, 3, 5, 7, 8, 9, 11, and 19 were submitted to analysis with the following results:

Number of sample	1	3	5	7	8	9	11	19
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Moisture . . .	11·55	12·14	11·77	9·56	14·24	10·11	12·13	10·97
Nicotine . . .	2·12	2·68	3·40	1·06	1·95	2·88	2·24	2·97
Total nitrogen . .	1·09	1·39	1·65	2·15	1·49	1·66	1·75	1·26
Ash	9·35	10·11	6·58	14·40	8·52	8·81	9·86	9·76
The ash contained:								
Lime CaO .	34·24	19·97	28·15	23·58	21·10	13·70	30·12	35·73
Magnesia MgO .	10·32	13·84	16·62	9·00	13·42	13·50	14·36	7·47
Potash K_2O .	17·88	31·73	24·16	29·29	28·22	34·82	23·04	22·30
Sulphuric acid SO_3 .	2·62	1·75	4·48	2·12	2·82	2·82	2·37	2·58
Chlorine Cl .	2·49	3·86	3·03	14·32	2·83	1·16	2·25	3·13

Samples 12 to 18 were too small for commercial valuation; the remaining samples were stated by experts to be useful tobaccos to blend with Virginia, and were valued as follows:

Nos. 1, 2: 8*d.* to 8½*d.* per lb.
" 3, 4, 8, 10: 7½*d.* to 8*d.* per lb.
" 5, 19: 7*d.* to 7½*d.* per lb.
" 6, 7, 9, 11: 6½*d.* to 7*d.* per lb.

The foregoing samples of Virginian tobacco represented, on the whole, tobaccos of very promising quality. They showed a considerable improvement on the previous samples, and this improvement is reflected in the somewhat higher valuations now quoted. The following general remarks may be made regarding them:

Type of Tobacco.—As pointed out in the previous report, it is advisable, for the preparation of flue-cured tobacco of Virginian type, to use tobacco grown from seed of types which have proved suitable for this purpose in the United States; and this plan has been adhered to in the case of these samples. As a result the samples conformed more closely than the former set with the requirements of tobacco manufacturers.

Composition.—The composition of the tobaccos was fairly satisfactory. They contained no more moisture than was necessary to keep them in good condition for transport, and the amounts of nicotine and nitrogen were not too high. The most noticeable feature was the small amount of mineral matter they contained. Tobaccos of the same type from the United States usually contain from 12 to 17 per cent. of ash. In this low percentage of ash the Mozambique tobaccos resemble those of Nyasaland (see this BULLETIN, 1909, 7, 266). This relatively small percentage of mineral matter has the effect of making the tobaccos flame, rather than glow steadily, but the defect was not very noticeable in the present samples, probably owing to the fact that the proportion of potash in the mineral matter was high. The percentages of deleterious ash constituents, sulphates, and chlorides, were fortunately low in all cases, except in sample No. 7, which contained a large excess of chlorine. This tobacco seemed to have been grown under much the same conditions as the others, and there is no obvious explanation of the large amount of chlorides it contained. Samples of this type of tobacco grown in future seasons at M'Zimbiti should be examined in order to ascertain whether this is a constant feature.

Grading.—It was pointed out in the previous report (p. 17) that efforts should be made to prepare the "brighter" kinds of this type of tobacco, and on the whole these samples were better than the previous set in this respect. There is, however, still considerable room for improvement, and when actual production on a commercial scale is undertaken the question of grading, so that each hand is uniform in colour, size, and quality, will need very careful consideration.

AIR-CURED CIGAR TOBACCOS

No. 20. Zimmer's Spanish.—Seed imported from Rhodesia, 1908. Grown on land manured with cow-peas and under shade.

The leaves varied in size from 5 by 13 in. to 8 by 21 in. Many of them were almost entirely green and unfermented; the rest varied in colour from dull orange-brown to dark brown, but nearly all showed green patches and "burns." The midribs were not too prominent.

The tobacco burnt fairly well. The ash cohered well, and was grey in colour with black patches.

It was analysed with the following results:

		Per cent.
Moisture		11·23
Nicotine		2·69
Total nitrogen		2·93
Ash		13·08
The ash contained:		
Lime	CaO	24·35
Magnesia	MgO	14·28
Potash	K_2O	36·50
Sulphuric acid	SO_3	6·36
Chlorine	Cl	8·03

The sample was valued by a firm of commercial experts at 6*d*. per lb.

No. 21. Havana.—Seed imported from Nyasaland, 1910. Grown on land manured with cow-peas and under shade.

The leaves had an average size of 6 by 13 in. They were medium reddish-brown to dark brown in colour, but many showed green patches. Most of the leaves showed "burns." The midrib and ribs were not too prominent, and the texture of the leaf was fine and tough. When wetted and allowed to partially dry, the leaves became very gummy and adhered strongly together. The tobacco did not burn well. The ash cohered fairly well, and varied in colour from light grey to nearly black in places.

This sample was valued at 4*d.* per lb.

These two tobaccos were fairly satisfactory in composition and they burnt fairly well. Their defects were due (1) to too early collection and (2) to faulty preparation, and especially under-fermentation. It seems clear, from the results of the examination of the former set of Mozambique tobaccos and the present set, that the M'Zimbiti Station is best adapted to the cultivation of tobaccos of the Virginian type, with possibly Levantine tobaccos. It would therefore seem to be advisable to devote attention chiefly to these types for the present.

LEVANTINE TOBACCOS

These samples were raised from seed of Turkish, Smyrna, and similar types of tobacco, the seed being obtained from Rhodesia or the Transvaal. They were grown according to the plan usually followed for such tobaccos, but two different methods of curing were adopted. The first seven were "flue-cured" by the method generally used for "bright" Virginian tobaccos, and the remaining seven were "air-cured," but no information was supplied as to the method followed in the latter case.

Flue-cured Samples

No. 22. Samsam.—Seed imported from Transvaal, 1910. Grown on virgin land.

The leaves were fairly uniform in size and measured from 5 by 11 in. to 6 by 13 in. They were mostly bright yellow in colour, changing to orange-brown at the edges. The texture was thin and papery. Many of the leaves showed "burns" and mould stains. The aroma of the leaves was poor.

The sample burnt readily in cigarette form. The ash cohered moderately well, and varied in colour from pale grey to nearly black.

No. 23. *Baffra.*—Origin of seed and cultivation same as No. 22.

The leaves varied in size from 3½ by 7½ in. to 4½ by 10 in., and were mostly bright yellow in colour. They nearly all showed blemishes and "burns." The aroma was poor.

The sample burnt well in cigarette form. The ash cohered well, and was light grey tinged with brown.

No. 24. *Xanthi.*—Seed imported from Rhodesia, 1909. Grown on virgin land.

The majority of the leaves varied in size from 3 by 7 in to 4 by 8 in., the rest being larger. They were dull, slightly greenish-yellow in colour. Many of the leaves showed mould stains. The aroma was poor.

The sample burnt fairly well. The ash cohered fairly well, and was mostly white.

No. 25. *Smyrna.*—Seed imported from Rhodesia, 1908. Grown on virgin land, 1910.

The leaves varied in size from 2½ by 6 in. to 4½ by 9 in., and were mostly dull yellow in colour. They showed many blemishes. The aroma was poor.

The sample burnt fairly well in cigarette form. The ash cohered well, and was light grey in colour.

No. 26. *Latakia.*—Seed imported from Transvaal, 1910. Grown on virgin land.

The leaves varied in size from 3 by 7 in. to 4 by 10 in. They were mostly dull yellow in colour, but a few showed a brownish tinge, and others were bright yellow. A few of the leaves showed "burns" and mould stains. The aroma was poor.

The sample burnt well in cigarette form. The ash cohered fairly well, and was light grey in colour.

No. 27. *Rhodesia Imported.*—Seed imported from Rhodesia, 1909. Grown on virgin land.

The leaves were fairly uniform in size, the average being 4 by 8 in. They were dull yellow with a tinge of orange, and most of them showed some blemishes. The aroma was poor.

The sample burnt well in cigarette form. The ash cohered fairly easily, and was light grey in colour.

No. 28. *Mahalla.*—Seed imported from Transvaal, 1909. Grown on virgin land.

The leaves were fairly uniform in size, the average being 4 by 10 in. In colour they were dull yellow with, in some cases, a slight brownish tint. Most of the leaves showed mould stains and "burns." The aroma was poor.

The sample burnt fairly well in cigarette form. The ash cohered fairly well, and was light grey in colour.

Air-Cured Samples

No. 29. *Rhodesia Imported.*—Origin and cultivation same as No. 27.

The leaves varied in size from 2 by 5 in. to 4 by 9 in., and were of fairly uniform dull brown colour. A few of the leaves showed spots, and many of them "burns." The aroma was poor.

The sample burnt fairly well in cigarette form. The ash cohered well, and was light grey in colour, excepting for a few darker patches.

No. 30. *Smyrna.*—Origin and cultivation same as No. 25.

The leaves were uniform in size, measuring 3½ by 7 in. They were medium brown in colour, and showed occasional green patches and mould stains. The aroma was poor.

The sample burnt fairly well in cigarette form. The ash cohered well, and was light grey in colour.

No. 31. *Samsam.*—Origin and cultivation same as No. 22.

The leaves varied in size from 3½ by 7 in. to 4 by 11 in. They were mostly medium to dull brown in colour. Most of the leaves showed "burns" or "stains." The aroma was poor.

The sample burnt fairly well in cigarette form. The ash cohered fairly satisfactorily, and was mostly light grey, but white in parts.

No. 32. *Mahalla.*—Origin and cultivation same as No. 28.

The leaves varied in size from 3½ by 8 in. to 5 by 12 in., and were mostly medium or dull brown in colour. Most of the leaves showed "burns" or "stains," and a few were mouldy. The aroma was poor.

The sample burnt fairly well in cigarette form. The ash cohered fairly well; it was irregular in colour, but was mostly light grey.

No. 33. *Baffra.*—Origin and cultivation same as No. 23.

The leaves varied in size from 2½ by 5½ in. to 4½ by 10 in., but were mostly 3½ by 8 in. They were of a medium, rather dull brown colour. Most of the leaves showed one or more "burns." The aroma was poor.

The sample burnt fairly well. The ash cohered fairly well, and was light grey in colour.

Three of the samples of Levantine tobaccos were analysed, with the following results:

Number of sample		22	26	31
		Per cent.	*Per cent.*	*Per cent.*
Moisture		11·47	12·31	9·87
Nicotine		0·26	0·83	0·20
Total nitrogen		1·05	1·42	1·24
Ash		11·42	7·38	7·71
The ash contained:				
Lime	CaO	23·55	34·71	22·32
Magnesia	MgO	14·80	13·75	11·71
Potash	K_2O	23·96	20·16	27·70
Sulphuric acid	SO_3	2·15	3·40	2·50
Chlorine	Cl	4·32	2·48	2·72

The samples were considered by experts to be suitable for the manufacture of cigarettes, and were valued as follows:

Nos. 29–33: *6d.* to *7d.* per lb.
Nos. 22–28: *5d.* to *7d.* per lb.

In composition and burning quality these tobaccos were all fairly satisfactory. Their chief defects were that they did not conform in size, and in aroma when smoked, with the corresponding types of Levantine tobaccos which appear in commerce. The first of these defects was probably due to the plants having been spaced too far apart, whilst the lack of aroma, and possibly to some extent the largeness of the leaves also, may have been due to the use of seed imported from Rhodesia or the Transvaal instead of direct from Turkey. One of the chief difficulties encountered in growing Turkish tobacco is the tendency of this type of tobacco to revert to the large leaf form, and this tendency is likely to be enhanced if seed is used from countries where the cultivation of Turkish tobacco is not thoroughly established.

If experiments with this type of tobacco are continued it would be well to obtain supplies of seed from Turkey, and the methods of cultivation and preparation adopted should at first, at all events, be similar to those used in that country.

THIRD SERIES (1912)

This consisted wholly of Virginian types of tobacco. The samples were too small for analysis, but they were submitted to general examination and valuation with the following results:

No. 1. *Bullion.*—The leaves varied in size from 5½ by 14½ in. to 9 by 17½ in., and in colour from dull "mahogany" to dark brown. Most of the leaves showed one or more spots.

The tobacco held fire moderately well, and burnt fairly well with a pungent smoke, leaving a dark grey ash with white patches.

No. 2. *Hester.*—The leaves varied in size from 6 by 12 in. to 8 by 16 in., and in colour from typical "mahogany" to dark brown. Some of the leaves showed one or more spots.

The tobacco held fire fairly well and burnt moderately well, leaving a dark grey ash. The smoke was rather pungent, but mild in flavour and aroma.

No. 3. *Sweet Orinoco.*—The leaves varied in size from 7 by 15 in. to 9 by 17½ in., and in colour from typical "mahogany" to dark "mahogany." All the leaves showed one or more spots.

The tobacco held fire well, and burnt well, leaving a dark grey ash. The smoke was mild in flavour and aroma, and though slightly pungent, was less so than that of the "Hester" leaf.

No. 4. *Raglan's Conqueror.*—The leaves varied in size from 7 by 12½ in. to 8½ by 14½ in., and in colour from bright "mahogany" to typical "mahogany." Most of the leaves had one or more small spots.

The tobacco held fire well, and burnt well, leaving a nearly white, flocculent ash. The smoke was mild in aroma and flavour, and not unpleasantly pungent.

No. 5. White Stem Orinoco.—The leaves varied in size from 7 by 12 in. to 9½ by 17½ in., and in colour from bright "mahogany" to dull "mahogany." A few of the leaves showed one or more spots.

The tobacco held fire well, and burnt fairly well, leaving a white ash. The smoke was mild in aroma and flavour, but rather pungent.

No. 6. Cooley Hybrid.—The leaves varied in size from 8½ by 16 in. to 11½ by 20 in., and in colour from typical "mahogany" to dark "mahogany." Most of the leaves showed one or more spots.

The tobacco held fire badly, and also burnt rather badly, leaving a dark grey ash. The smoke was mild in aroma and flavour, but rather pungent.

The samples were submitted to a firm of manufacturers, who valued them as follows (January 1913):

Sample	Variety	Value in the United Kingdom. *Per lb.*
1.	Bullion	5½*d.*
2.	Hester	6*d.*
3.	Sweet Orinoco	6*d.*
4.	Raglan's Conqueror	7*d.*
5.	White Stem Orinoco	8*d.*
6.	Cooley Hybrid	5*d.*

On the whole, these tobaccos were of darker colour than the samples of the corresponding varieties examined previously. They were of fair quality, though No. 6 had poor burning properties, and all of them furnished a rather pungent smoke.

These tobaccos would be readily saleable in the United Kingdom, but better prices would be obtained for brighter tobaccos of the same type.

TOBACCO FROM PAPUA

The climate of Papua is well suited to tobacco, which is grown by the natives throughout the Territory. It has also been grown successfully at the Government Experiment Stations, but its cultivation on a commercial scale was not undertaken until 1910–11, when 15 acres were planted with cigar tobacco in the neighbourhood of the Laloki River, 14 to 15 tons of tobacco being harvested.

Two samples of cigar tobacco, stated to be grown on the Katea Plantation, have been examined at the Imperial Institute with the following results:

Havana Type.—The leaves mostly varied in size from 16½ by 9 in. to 20 by 10½ in., a small proportion being less than 9 in. wide. The colour ranged from greyish-brown to dark brown; a few of the leaves showed white spots. The leaves were in most cases thin and of fine texture, with large and prominent midribs. The tobacco held fire well, and left a grey ash.

The results of examination expressed on material as received were as follows:

		Per cent.
Moisture		9·76
Nicotine		1·44
Nitrogen		2·76
Ash		18·49
The ash contained:		
Lime	CaO	25·38
Magnesia	MgO	9·64
Potash	K_2O	25·04
Sulphates, expressed as sulphuric acid	SO_3	3·70
Chlorides, expressed as chlorine	Cl	6·13

The tobacco was submitted to two firms of experts, who agreed in the view that it did not exhibit the characteristics of true Havana leaf, and that the thick veins and dark colour would render most of it unsuitable for the outer wrappers of cigars. Both firms, however, considered the burning qualities to be fairly good, and recommended that the tobacco should be carefully cultivated under expert supervision. One of the firms estimated the value of the sample in a sound and dry condition at about *9d.* per lb. in London.

Sumatra Type.—The leaves varied in size from 14½ by 6½ in. to 20½ by 12 in., with a small proportion of narrower leaves. The colour varied from a light, warm brown to a dull brown, the latter predominating. The individual leaves were fairly uniform in colour, except for small green or blackish patches. They were mostly thin, but in some cases coarse, and the veins and midribs were rather prominent, though less so than in the case of the preceding sample. The tobacco burnt well, and left a dark grey ash.

The following results expressed on material as received were obtained on examination :

		Per cent.
Moisture		10·50
Nicotine		1·45
Nitrogen		2·62
Ash		17·70
The ash contained :		
Lime	CaO	20·20
Magnesia	MgO	7·79
Potash	K_2O	33·36
Sulphates, expressed as sulphuric acid	SO_3	2·85
Chlorides, expressed as chlorine	Cl	3·90

The tobacco was submitted to the same firms as the preceding sample. Both firms reported that the colour of most of the sample was too dark, and that for this reason it would be unsuitable for cigar wrappers. They considered, however, that a good marketable product could be produced by careful cultivation under proper supervision, as the tobacco was of good quality and burnt well. One of the firms valued it at about *9d.* per lb. in London, if marketed in dry and sound condition.

These tobaccos from the Katea Plantation were quite satisfactory in composition, and would be readily saleable in the United Kingdom. The defects which they showed could probably all be avoided in future by more careful cultivation, curing, fermenting, and grading. Judging from these two samples there seems to be no reason why cigar tobacco of a high grade should not be produced in Papua under expert supervision.

THE UTILISATION OF SUDAN DURA

REFERENCE has already been made in this BULLETIN (1911, **9**, 253) to the possibility of an export trade in dura grain from the Sudan to Europe, and an account was given of feeding trials carried out in Austria, with the object of comparing the feeding value of Sudan dura with that of maize for fattening oxen and for milch cows. Since that date a series of technical trials and feeding experiments has been carried out with dura forwarded to the Imperial Institute from the Sudan, and a summary of the results is given in the following pages.

A considerable quantity of dura or "dari" is already imported into the United Kingdom, chiefly as a food for poultry, and the following table shows the quantities and values of this grain, imported from various sources during 1909–11.

	Quantity.			Value.		
	1909.	1910.	1911.	1909.	1910.	911.
	cwt.	*cwt.*	*cwt.*	£	£	£
Russia	45,812	—	960	11,010	—	250
Turkey, European . .	1,144	—	3,685	310	—	977
Turkey, Asiatic . . .	47,131	48,589	123,933	14,999	13,196	34,586
Egypt[1]	1,346	55,381	14,069	485	14,657	3,760
Persia	8,926	13,078	4,880	2,533	3,548	1,255
Other foreign countries . .	14,258	22,234	7,280	4,164	5,775	2,022
Total from foreign countries	118,617	139,282	154,807	33,501	37,176	42,850
Cape Province . . .	11,327	18,524	900	2,856	4,417	317
British India . . .	252,542	237,473	53,475	74,262	66,204	14,695
Other British possessions .	5,142	9,075	1,960	1,473	2,221	520
Total from British possessions . .	269,011	265,072	56,335	78,591	72,842	15,532
Total . . .	387,628	404,354	211,142	112,092	110,018	58,382

[1] *The dura imported from Egypt is probably in part Sudan dura received* via *Egypt.*

Dura is cultivated throughout the Sudan, where it forms the staple food of the people; most of the product is at present consumed locally, but an export trade has already been built up, the quantities and values of the exports for 1909–11 being shown in the following table:

	1909.	1910.	1911.
tons	22,352	32,377	17,794
£	140,156	121,139	88,913

The decrease in the amount of dura exported during 1911 was due mainly to a failure of the crop owing to insufficient rain, whilst the cultivation of the grain was forsaken to some extent for the more remunerative industries of gum collection and sesamum cultivation. The prospects of a good harvest during 1912 were very slight in many of the provinces, owing to lack of rain and prevalence of pests, with the result that the people kept back their supplies, thus running the prices up to a very high figure. As a consequence of this it became necessary to import considerable quantities of dura, the amount imported during the first nine months of 1912 being 3,103 tons, valued at £24,547, as compared with 13 tons, valued at £62, during the corresponding period of 1911.

The following table gives the prices prevailing at some of the chief ports in the United Kingdom for maize and dura during 1912:

DURA.

Port.	Date.	Variety.	Price.
Hull	May 30	Rangoon	37*s.* per 480 lb.
Liverpool	May 10	Syrian	29*s.* 6*d.* to 31*s.* 6*d.* per 480 lb.
Bristol	May 9	Syrian	28*s.* 6*d.* to 29*s.* per 400 lb.
Bristol	May 9	Persian	24*s.* 6*d.* per 400 lb.
London	Feb. 23	Ordinary white	26*s.* per 480 lb.
London	Feb. 23	Small reddish	26*s.* per 480 lb.
London	Nov. 9	Sudan	£6 per ton.

MAIZE.

Port.	Date.	Variety.	Price.
Hull	May 30	River Plate	33*s.* 6*d.* per 480 lb.
Hull	May 30	Gal-Fox	33*s.* 6*d.* per 480 lb.
Liverpool	May 10	American mixed, old	7*s.* per 100 lb.
Liverpool	May 10	Cinquantina, old	9*s.* per 100 lb.
Liverpool	May 10	Turkish	6*s.* 9*d.* and 6*s.* 9½*d.* per 100 lb.
Liverpool	May 10	Plate, Yellow, new	7*s.* and 7*s.* 0½*d.* per 100 lb.
Bristol	May 9	Bessarabian, old	34*s.* per 480 lb.
Bristol	May 9	Gal-Fox	31*s.* 9*d.* per 480 lb.
London	Feb. 23	Odessa	26*s.* 6*d.* per 480 lb. (*ex* ship).
London	Feb. 23	Odessa	28*s.* per 480 lb. (landed).
London	Feb. 23	Mixed American	30*s.* per 480 lb. (*ex* ship).

It will be seen that, on the whole, dura fetches prices similar to those paid for maize.

The consignment of dura used in the feeding and technical trials weighed 10 tons, and was stated to represent the average quality of Sudan "Faterita" dura. It consisted of small round seeds, about ⅓ cm. in diameter; the testa was fairly hard and brittle, and the interior white and floury. The seeds were mostly white, but a small percentage were brown.

The dura as received contained about 2 per cent. of dirt, and a very slight amount of husk and small, undeveloped seeds.

A sample of the grain, previously freed from dirt, was analysed at the Imperial Institute with the following results:

	Per cent.
Moisture	8·45
Crude proteins	13·06
Consisting of:	
True proteins	12·98
Other nitrogenous substances	0·08
Fat	3·30
Carbohydrates (by difference)	72·45[1]
Fibre	1·03
Ash	1·71
Nutrient ratio	1 : 6·1
Food units	113·3

[1] *Including* 62·66 *per cent. of starch, as determined by acid hydrolysis;* 0·66 *per cent. of reducing sugars, expressed as dextrose; and* 0·82 *per cent. of sugars which reduce after inversion, expressed as sucrose.*

The dura contained no alkaloids or cyanogenetic glucosides.

TECHNICAL TRIALS

Samples of the dura were submitted for experimental trial to starch and glucose manufacturers, and to brewers and distillers. The results obtained are summarised below.

Starch Manufacture.—A firm of starch manufacturers stated that they had succeeded with some difficulty in separating about 43 per cent. of starch from the grain, but that it was very difficult to get a clean separation. It would therefore not be easy to manufacture starch from the dura with existing plant, and the firm considered that special machinery would have to be devised for the purpose.

Two other firms who were consulted expressed the opinion that the dura would not be suitable for making starch.

Glucose Manufacture.—Trials of dura for the manufacture of glucose were made by a large firm, who reported that they could not utilise the grain, as it is not so good as maize for their purpose.

Distilling.—A firm of distillers stated that the grain could certainly be used as a source of alcohol, though its utilisation for this purpose would offer certain initial technical difficulties. They added that the price would be an important point, and that the dura would probably have to be sold in London at not more than 15*s.* per 480 lb. in order to compete with other materials for distilling purposes.

Another firm of distillers stated that they had used dura some years ago, and that with them the choice between this grain and maize was only a matter of price.

A third firm stated that they had tried dura previously, but found it unsuitable for distilling purposes, as it produced a very inferior spirit. Another firm, who are manufacturers of silent spirit, reported that the results of laboratory experiments with the grain were decidedly encouraging, and that it was proposed to carry out a technical trial on a large scale when suitable plant was available in the firm's new factory.

Brewing.—A firm of brewers stated that for use in brewing the dura would require special preparation. They submitted a sample to a technical chemist, who stated that he had examined the grain on several previous occasions, but did not consider it a desirable or economical brewing material, adding that the percentage of fat was rather high, and that the grain did not yield a good extract.

Another firm expressed the opinion that the grain would have to be manufactured into "flakes" before it would be of any service in brewing; and they submitted it to a maker of flaked malt, who, however, after careful examination, did not consider the material to be promising.

A third brewing firm stated that they had previously examined dura, but had found that the percentage of fat present rendered it unsuitable for brewing purposes.

Another firm, after carrying out technical trials with the grain, also reported that the presence of fat was an objection to its use in brewing, but they added that this difficulty might perhaps be overcome.

FEEDING TRIALS

A large quantity of the dura was supplied to Prof. Douglas Gilchrist, of the Agricultural Department of Durham University, in order that feeding trials might be carried out. The results of the experiments, which were designed to compare dura with maize as a food for dairy cows, have been published in *Offerton Bulletin*, No. 4, 1913, *Education Committee, Durham County Council*, by Mr. F. P. Walker, B.Sc. (Edin.), Adviser in Agriculture at Armstrong College, Newcastle-on-Tyne.

Mr. Walker's report is as follows: Ten milch cows were selected after preliminary trials, lasting over a period of four weeks, and divided into two lots of five each.

At the end of the preliminary trials the two lots stood as follows:

	Total yield of milk in pints, per lot, per day.	Average yield of milk, per cow, per day.	Percentage of butter-fat in total daily yield of milk.	Average liveweight.
Lot I. . .	136·5	27·3	3·53	1177·4 lb.
Lot II. . .	135·5	27·1	3·48	1194·2 lb.

The actual experiment with dura was carried out in two sections. The cows were fed on certain rations for a period of eight weeks, after which the rations were reversed, and the experiment continued for a similar period under the altered conditions. In the first experiment the rations used per cow, per day, were as follows:

Lot I.	Lot II.
6 lb. Soya cake.	6 lb. Soya cake.
4 " Maize meal.	4 " Dura meal.
60 " Swedes.	60 " Swedes.
12 " Meadow hay.	12 " Meadow hay.
7 " Oat straw.	7 " Oat straw.

Nutritive ratio of above rations, 1 : 5.

From January 26 to 31 both lots received equal quantities of Egyptian cotton cake instead of soya cake, and it will be noted in Table I. that there was a considerable drop on that account in the average daily yield.

The cake and meal, with a small portion of chopped straw, were fed dry and the cows were allowed drinking water *ad lib.*

The yields of milk, the percentage of fat, and of "solids not fat," are tabulated separately, the figures given in the tables being the weekly averages. Each table shows the fluctuation from week to week at each milking. There are no very striking differences shown between the yields of milk from the two lots. The average total yield for the eight weeks was identical for both.

TABLE I.—AVERAGE QUANTITY OF MILK IN PINTS, PER LOT, PER DAY, FOR EIGHT WEEKS.

	Lot I. (Maize meal).				Lot II. (Dura meal).			
Week ending.	Morn.[1]	Noon.[1]	Even.[1]	Total.	Morn.[1]	Noon.[1]	Even.[1]	Total.
Dec. 28 . .	62·0	43·5	28·5	134·0	58·5	42·0	29·0	129·5
Jan. 4 . .	62·5	42·0	28·0	132·5	60·0	43·0	28·5	131·5
,, 11 . .	63·0	40·5	28·5	132·0	60·0	41·0	28·5	129·5
,, 18 . .	62·0	39·0	26·5	127·5	61·0	42·0	28·0	131·0
,, 25 . .	60·0	39·5	28·0	127·5	60·5	41·0	29·0	130·5
Feb. 1 . .	56·0	36·0	26·0	118·0	57·0	39·5	28·0	124·5
,, 8 . .	59·0	40·0	28·0	127·0	57·0	41·0	28·0	126·0
,, 15 . .	60·5	40·0	28·0	128·5	57·0	39·5	27·5	124·0
Average per lot, per day for each of eight weeks	60·62	40·06	27·68	128·3	58·87	41·12	28·31	128·3

[1] *The times of milking were 5 a.m., 12.30 p.m., and 6.30 p.m.*

Quality of the milk.—The average percentage of butter-fat in the milk of each lot is shown in Table II. The average results are again strikingly similar, and the dura meal compares well with the maize. A point of interest as to the quality of the morning's milk of a group of ten cows is that with the maize-fed lot the milk fell fourteen times below the relative standard, while with the dura-fed cows the number of times below during the same period of eight weeks was eleven.

TABLE II.—AVERAGE PERCENTAGES OF BUTTER-FAT IN MILK FOR EACH OF EIGHT WEEKS.

	Lot I. (Maize meal).			Lot II. (Dura meal).		
Week ending.	Morn.	Noon.	Even.	Morn.	Noon.	Even.
December 28	2·9	3·8	3·8	3·1	3·8	3·8
January 4	3·1	3·8	3·9	3·0	3·8	3·9
,, 11	3·1	3·6	3·6	3·1	3·9	3·7
,, 18	3·0	4·0	3·7	3·0	3·7	3·6
,, 25	3·0	3·8	3·6	3·0	3·7	3·6
February 1	3·2	3·5	4·0	3·3	3·8	3·7
,, 8	3·0	4·0	3·9	3·1	3·9	3·9
,, 15	3·1	3·7	4·1	3·0	3·6	4·0
Averages for each of eight weeks	3·05	3·77	3·82	3·07	3·77	3·77
Times milkings were under standard during eight weeks	14	—	—	11	—	—
Highest	3·5	4·7	4·8	4·6	4·3	4·6
Lowest	2·7	3·0	5·0	2·7	3·2	3·2

	Lot I.	Lot II.
Average percentage of butter-fat in total daily yield .	3·44	3·44
Total butter-fat per day (lb.).	4·41	4·42

TABLE III.—PERCENTAGES OF "SOLIDS NOT FAT" IN MILK FOR EIGHT WEEKS.

Week ending.	Lot I. (Maize meal).			Lot II. (Dura meal).		
	Morn.	Noon.	Even.	Morn.	Noon.	Even.
Dec. 28	9·0	8·9	9·2	9·1	8·9	9·3
Jan. 4	9·2	9·1	9·4	9·2	9·1	9·4
" 11	9·0	8·8	9·0	9·0	8·8	9·0
" 18	9·0	9·0	9·0	9·0	8·8	9·0
" 25	8·9	8·8	9·0	8·9	8·9	9·1
Feb. 1	8·9	9·0	9·0	8·9	9·0	9·0
" 8	8·9	8·9	9·0	8·9	9·0	9·0
" 15	8·9	8·9	9·0	8·9	8·9	9·0
Averages for eight weeks	8·97	8·92	9·07	8·98	8·92	9·08
Times milkings were under standard	—	—	—	1	—	—
Highest	9·5	9·6	9·8	9·5	9·3	9·9
Lowest	8·6	8·5	8·7	8·4	8·5	8·5

	Lot I.	Lot II.
Average percentage of "solids not fat" in total daily yield	8·98	8·98
Total solids not fat per day (lb.)	11·52	11·52

The "solids not fat" in both lots of milk were well above the standard, though on one occasion with the dura-fed lot they were just below. Having regard, therefore, to quantity and quality of milk produced in this experiment, the Sudan dura meal is as good a food for milch cows as maize meal when fed in similar quantities.

TABLE IV.—AVERAGE LIVEWEIGHT, IN LB., PER COW OF EACH LOT.

	Commencement.	January 17.	February 16.	Average gain or loss during experiment.
Lot I.	1177·4	1174·6	1195·6	+ 18·2
Lot II.	1194·2	1164·8	1197·0	+ 2·8

Liveweight of Cows.—The average liveweight of each cow in the lots is shown in Table IV. The difference in the increase per cow during the experiment is small, but shows in favour of the maize meal. It may be noted that throughout the experiment the cows milked well, and while the rations were calculated to produce a good milk flow there was no excess of food for fat production in addition, the cows throughout remaining in practically a healthy milk-producing state of flesh. The cows were also in calf either at the commencement of the experiment or during its continuance.

As soon as the above experiment was completed, the rations, as already mentioned, were reversed. The object was to discover whether the dura would act in a similar manner as in the previous experiment. Unfortunately during this experiment barley and wheat straw had to be used instead of oat straw. All straw and hay of season 1911 was of good quality owing to the exceptionally dry season, and the cows ate the barley and wheat straw well. The results are given in the following tables. At the end of the sixteenth week the cows were still milking well, and the average yield of the two lots of cows per day for the second eight weeks was remarkably close.

TABLE V.—AVERAGE QUANTITY OF MILK IN PINTS, PER LOT, PER DAY, FOR EIGHT WEEKS.

	Lot I. (Dura meal).				Lot II. (Maize meal).			
Week ending.	Morn.	Noon.	Even.	Total.	Morn.	Noon.	Even.	Total.
Feb. 22 .	60·5	40·0	26·5	127·0	56·5	40·5	26·5	123·5
„ 29 .	60·0	40·0	27·0	127·0	57·5	40·5	28·0	126·0
March 7 .	58·5	40·0	28·0	126·5	54·0	39·0	27·5	120·5
„ 14 .	58·0	38·0	26·0	122·0	54·5	38·5	25·0	118·0
„ 21 .	57·0	36·0	25·0	118·0	55·0	37·5	25·0	117·5
„ 28 .	55·0	35·5	25·0	115·5	53·0	37·0	24·5	114·5
April 4 .	55·5	34·5	25·0	115·0	53·0	36·0	23·0	112·0
„ 11 .	54·0	32·0	23·0	109·0	52·5	34·5	23·0	110·0
Average per lot, per day, for eight weeks	57·31	37·0	25·68	120·0	54·5	37·93	25·31	117·7

Quality of the Milk.—The percentage of butter-fat in the milk of each lot in this experiment is shown in Table VI. As a rule, as the period of lactation lengthens, the quality of the milk improves. Contrary to the general rule, the quality of the milk throughout this experiment was slightly below the quality during the first experiment. A popular explanation of the fact would probably be that the substitution of barley and wheat straw for oat straw would naturally produce a less nutritious food, but the liveweight increase of the cows shows that they had more than sufficient food for milk-production, and it is a well-known fact that, excepting for a very short period, it is impossible to materially alter the composition of the milk by the use of different foods.

The slightly inferior quality of the milk is therefore not easy to explain, but a little light may be thrown on the subject as being due perhaps to a peculiar seasonal effect, inasmuch as during the spring of 1912 several complaints were received at the Armstrong College as to the general poorness of milk from widely separated farms.

At any rate it is especially noticeable from Table VI. how low the percentage of fat was in both groups during the mornings. The average percentage for each of the eight weeks was actually below the relative 3 per cent. standard. The number of times the milk of the dura-fed cows in Lot I. was below the relative standard in the morning was twenty-seven, and twice at noon; while during a similar period for the maize-fed group the morning's milk was twenty-one times below 3 per cent. As the cows of Lot I. in the last experiment when maize-fed produced low-standard milk oftener than the dura, it shows again how, apart altogether from food, the individuality of particular cows governs the quality of the milk produced.

TABLE VI.—AVERAGE PERCENTAGES OF BUTTER-FAT IN MILK FOR EACH OF EIGHT WEEKS.

	Lot I. (Dura meal).			Lot II. (Maize meal).		
Week ending.	Morn.	Noon.	Even.	Morn.	Noon.	Even.
Feb. 22	3·0	3·7	3·9	3·0	3·8	3·9
„ 29	2·9	3·6	4·0	3·0	3·8	3·8
Mar. 7	3·0	3·6	4·0	3·0	3·6	4·0
„ 14	3·0	3·4	4·0	3·0	3·7	4·0
„ 21	2·9	3·4	3·9	2·9	3·7	3·9
„ 28	3·0	3·4	4·0	3·0	3·4	4·0
April 4	3·0	3·3	3·9	3·0	3·4	3·9
„ 11	3·0	3·5	3·9	3·0	3·6	3·9
Average for each of eight weeks	2·97	3·48	3·95	2·98	3·62	3·92
Times milkings were under the standard during eight weeks	27	2	—	21	—	—
Highest	3·4	4·1	4·6	3·3	4·3	4·6
Lowest	2·6	2·8	3·5	2·7	3·0	3·2

	Lot I.	Lot II.
Average percentage of butter-fat in total daily yield	3·33	3·39
Total butter-fat per day (lb.)	4·00	3·98

TABLE VII.—PERCENTAGES OF "SOLIDS NOT FAT" IN MILK FOR EIGHT WEEKS.

Week ending.	Lot I. (Dura meal). Morn.	Lot I. (Dura meal). Noon.	Lot I. (Dura meal). Even.	Lot II. (Maize meal). Morn.	Lot II. (Maize meal). Noon.	Lot II. (Maize meal). Even.
Feb. 22	8·9	8·9	9·0	8·9	9·0	9·0
,, 29	8·9	8·8	8·9	8·9	8·9	9·1
Mar. 7	8·8	8·8	8·8	8·8	8·8	9·0
,, 14	8·8	8·8	8·9	8·8	8·8	9·0
,, 21	8·7	8·9	8·9	8·8	8·9	9·0
,, 28	8·8	8·7	8·9	8·8	8·8	8·9
April 4	8·8	8·8	8·9	8·9	8·8	9·0
,, 11	8·8	8·8	8·8	8·8	8·6	8·9
Average for eight weeks .	8·81	8·81	8·88	8·83	8·82	8·98
Times milkings were under standard	2	—	1	1	3	1
Highest	9·3	9·3	9·2	9·3	9·1	9·2
Lowest	8·3	8·5	8·2	8·4	8·2	8·3

	Lot I.	Lot II.
Average percentage of "solids not fat" in total daily yield	8·82	8·86
Total "solids not fat" per day (lb.)	10·58	10·43

The "solids not fat" were, during the experiment, above the standard, although, in sympathy with the general poorness of the milk in fat, there were three occasions on which they fell below the standard with Lot I. and five with Lot II. cows.

Liveweight of Cows.—The average liveweight of the cows is shown in the following table:

TABLE VIII.—AVERAGE LIVEWEIGHT, IN LB., PER COW OF EACH LOT.

	End of first experiment.	March 15.	April 13.	Average gain or loss during experiment.
Lot I. . . .	1195·6	1173·2	1204·0	+ 8·4
Lot II. . . .	1197·0	1167·6	1223·6	+ 26·6

The fluctuation in the average liveweight of the cows during this experiment is shown in Table VIII. The increase during the experiment in actual liveweight is again in favour of maize meal. So far, then, as quantity and quality of milk are concerned, in both of these experiments dura meal has equalled maize, but the greater increase in liveweight of the maize-fed cows favours maize as being the better food for beef production.

A careful examination of these results, summarised for the two experiments, which are naturally complementary to each other, will show that so far as actual yields of milk, percentage of butter-fat and non-fatty solids are concerned, dura and maize have given exactly the same results. When, however, the increase in weight of the cows is taken into consideration, maize has shown itself to be the better food. These results confirm an experiment which was carried out in Austria with Sudan dura compared with Hungarian maize during the year 1907 (*loc. cit.*).

Summary of Results

(*a*) The chemical composition of "Sudan dura" closely resembles that of maize.

(*b*) The experiments were carried out at Offerton Hall for a period of sixteen weeks during the winter of 1911–12.

(*c*) The cows used in the experiment were selected after careful preliminary trials from a greater number.

(*d*) These cows were divided into two lots of five each.

(*e*) The rations for the two lots were identical, except that in one case "maize meal" was used, while in the other an equal quantity of "dura meal" was employed.

(*f*) For the first eight weeks Lot I. received maize meal, while Lot II. received dura meal; for the second eight weeks Lot I. received dura meal, while Lot II. received maize meal.

(*g*) The cows throughout the experiment relished their food, and the results, so far as flow of milk and quality (both as regards fat and non-fatty solids), were practically identical.

(*h*) Maize, so far as increase in liveweight of the cows was concerned, was a slightly better food than dura.

(*i*) The results certainly indicate that dairy farmers might with advantage use dura as a substitute for maize, especially in case of the former being the cheaper food per ton.

(*j*) Contrary to general experience, for some reason difficult to explain, the milk of both lots of cows was slightly inferior in quality during the later period of the trials.

A quantity of the grain was also supplied to the South

Eastern Agricultural College at Wye, where it was tested as a feeding stuff for both cattle and sheep, with the following results:

Milch-cows.—Twenty cows were fed with dura meal as a preliminary trial, but some of them did not appear to relish it unless it was mixed with other feeding stuffs. Those cows which ate the dura meal readily were fed with it in increasing quantities for six weeks, without any noticeable effect on their condition. The quantity of milk was not affected, and the only important results observed were a deepening of the colour of the butter made from the milk and a lowering of its melting-point when the amount of dura meal fed to the cows was increased beyond a certain point. These circumstances, however, would be advantageous in winter, when the foodstuffs commonly used render the butter pale and hard.

Sheep.—In this case the dura was cracked or "kibbled" instead of being ground into meal, and was readily eaten in this form by the sheep. The rather brittle nature of the cracked grain makes it very satisfactory as a food for sheep, and it would perhaps be specially useful for fattening the animals in winter.

GENERAL CONCLUSIONS

Three independent series of feeding trials have now been carried out in Europe with Sudan dura, and the results show that this grain is a satisfactory feeding stuff, that it is about equal in value to the better-known feeding stuff maize, and that it can be substituted for the latter without disadvantage. The results of the technical trials recorded above indicate that dura grain could probably be substituted for maize in the manufacture of certain kinds of spirit. These two uses are probably sufficient to account for all the Sudan dura that can be exported for the next few years, even if the harvests are good.

In the brewing industry and in the manufacture of starch and glucose the use of dura in place of maize presents certain technical difficulties which can probably be overcome, and which are only to be expected when attempts are made to utilise a comparatively new product in a highly technical industry already using well-known materials obtainable in large quantities and of uniform quality.

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CAMPHOR OIL AND CRUDE CAMPHOR FROM THE FEDERATED MALAY STATES

The samples of camphor oil and crude camphor which are the subject of this report were forwarded to the Imperial Institute from Kuala Lumpur in September 1912. They were stated to represent materials obtained in the distillation of camphor from plants grown on the experimental plantations of the Agricultural Department.

Camphor Oil

This sample consisted of a pale yellow, cloudy oil containing a large amount of crystalline deposit, and possessing a mild camphoraceous odour.

The camphor in the oil was separated by cooling to – 10° C., and was then filtered off and thoroughly pressed. The quantity of camphor thus obtained amounted to 19·3 per cent. by weight of the original oil.

The oil from which the camphor had been removed possessed a mild, rather pleasant, slightly camphoraceous odour. It had the following constants:

Specific gravity at $\frac{15^\circ \text{C.}}{15^\circ \text{C.}}$	0·913
Optical rotation in 100 mm. tube at 18° C. . . .	+41° 1′

The oil was found to contain no safrole. This is apparently accounted for by the fact that it was distilled from the prunings of young trees (see *Bulletin* No. 15, 1912, of the Federated Malay States Department of Agriculture). According to *Der Pflanzer* (1906, **2**, 333), a specimen of camphor oil distilled in German East Africa from the leaves and twigs of trees one to two and a half years old was reported to contain no safrole.

The oil was submitted for valuation to commercial experts in England and in Germany. The English expert stated that it was difficult to value this oil accurately, but that if free from camphor it should be worth over 7½*d.* or 8*d.* per lb. in London (November 1912).

The German firm stated that they could not assign a definite value to the oil, as they do not use camphor oils containing no safrole, but they considered that it might possibly be worth about 30*s.* per cwt. delivered in Europe (November 1912).

Japanese camphor oil as marketed at the present time is practically free from camphor, which is extracted before shipment, and it is chiefly of value on account of the safrole it contains. As this camphor oil from the Federated Malay States does not contain any safrole, it cannot compete with the Japanese product.

Crude Camphor

This sample consisted of very pale brown crystals possessing the characteristic odour of camphor.

On pressing to remove oil and moisture the material lost 11 to 12 per cent. of its weight, indicating that it contained 88 to 89 per cent. of camphor. This proportion compares favourably with the percentage recorded for crude camphor from Japan and Formosa.

The sample of crude camphor and the clean camphor obtained from it by pressing were optically examined with the following results:

	Specific rotation.
Crude camphor as received	+40° 50′
" " after pressing	+42° 20′
Camphor obtained by dissolving the crude camphor in benzene and recrystallising	+41° 25′

It may be added that the camphor separated from the preceding sample of camphor oil by cooling the oil to −10° C. had a specific rotation of +42° 20′.

These specific rotations agree fairly well with those usually recorded for refined camphor, which vary between 41° and 44°.

The crude camphor was submitted to a firm of commercial experts, who reported that it appeared to be very similar in quality to Chinese "leaf" camphor, which is occasionally put on the market in small quantities. They considered that the material would realise £6 to £6 5*s.* per cwt. in London (November 1912), with the better quality of Japanese monopoly B. camphor at £7 2*s.* 6*d.* per cwt.

The results of this investigation indicate that the sample of camphor is of satisfactory quality, and would be readily saleable as crude camphor in the United Kingdom.

The camphor oil as received at the Imperial Institute contained nearly one-fifth of its weight of camphor, and this should be separated, if possible, before the oil is exported. The oil also differs from Japanese camphor oil in containing no safrole, and for this reason its value can only be determined by further investigation.

OIL OF *EUCALYPTUS CITRIODORA* FROM MAURITIUS

Two samples of *E. citriodora* oil from Mauritius were received recently at the Imperial Institute for examination. Both samples consisted of pale yellow oil with the strong characteristic odour of citronella. They were examined, with the results given in the following table, which also includes the constants of commercial *E. citriodora* oil.

	Sample No. 1.	Sample No. 2.	Oil of *E. citriodora* according to Gildemeister and Hoffman.
Specific gravity at $\frac{15° \text{C.}}{15° \text{C.}}$.	0·877	0·879	0·870 to 0·905
Optical rotation in 100 mm. tube at 21° C. . . .	+0° 4′	+1° 16′	(Specific rotation up to +2°)
Acetylisable constituents, *per cent.*	81·1	87·1	—
Solubility in 70 per cent. alcohol	Soluble in 3 or more vols.	Soluble in 2·6 or more vols.	Soluble in 4 to 5 vols.

These samples possessed the usual characteristics of *E. citriodora* oil; they were of satisfactory quality, and similar oil would be readily saleable in the United Kingdom. Sample No. 2 was superior to No. 1, since it contained a larger proportion of the "acetylisable constituents" to which the characteristic odour is due.

The oil was submitted to several firms of commercial experts, who reported on it as follows:

(1) A firm of wholesale druggists stated that there is a fair demand for this oil at 5*s.* to 5*s.* 6*d.* per lb. (November 1912).

(2) A German firm of distillers reported that the oil resembles the *E. citriodora* oil imported from Australia which is usually sold at about 4*s.* 6*d.* per lb. in London.

(3) A firm of brokers in London considered that they could dispose of a few tons of the oil annually, if it could be offered at not more than 2*s.* 6*d.* per lb., ex warehouse (December 1912).

(4) A large firm of soap-makers stated that *E. citriodora* oil was being sold by several London merchants at 3*s.* 10*d.* to 5*s.* per lb. (November 1912), but that for their own purposes this would be too high a price. They considered, however, that they would probably be able to use the oil in fairly large quantities if they could buy it at about 2*s.* per lb.

(5) A London dealer in essential oils stated that he would be glad to receive consignments of this oil for sale, adding that the current value (January 1913) for the best quality was about 4*s.* per lb., but that he had sometimes purchased the oil at as low a price as 2*s.* 2*d.* per lb.

The reason for the considerable variation in the price quoted by different firms for this oil is that the best qualities of *E. citriodora* oil now find a limited use for certain special purposes at prices varying from 4*s.* to 5*s.* per lb. This, however, forms a very restricted market, which could be easily overstocked. From the enquiries made in the course of the present investigation it seems clear that oil of the quality represented by these samples would be suitable for these purposes, and it was recommended that a small consignment of the oil should be forwarded for experimental sale in London.

Apart from this special use, *E. citriodora* oil would be very largely used for perfuming soaps if it could be marketed in the United Kingdom at from 2*s.* to 2*s.* 6*d.* per lb., and the quotations of this order given above represent about the price which soap-makers are prepared to pay for large quantities of the oil.

MARJORAM OIL FROM CYPRUS

In previous numbers of this Bulletin (1906, **4**, 296; 1908, **6**, 208; 1911, **9**, 308, 388), principally in connection with the origanum oil of Cyprus, attention has been directed to the confusion that at present exists regarding the botanical origin of the various oils that appear in commerce as "origanum" oils. This confusion appears to be mainly due to the fact that in many cases chemists who have examined the commercial oils have not taken the precaution of comparing the oil they examined with oil from a well-authenticated specimen of the plant from which the commercial oil was supposed to have been prepared. But the trouble is also in part due to the difficulty experienced on the botanical side in identifying some of the plants which yield these oils. As an instance of this kind it may be mentioned that the plant which yields the origanum oil of Cyprus is referred by Dr. Stapf, of the Royal Gardens, Kew, to *Origanum dubium*, Boiss., whilst Mr. E. M. Holmes, F.L.S., considers that it is *O. majoranoides*, Willd. Similarly the plant yielding the "Cyprus marjoram oil," now to be described, has been referred by Dr. Stapf to *O. majoranoides*, Willd., and by Mr. E. M. Holmes to *O. Maru*, Linn. Unfortunately, oils have never been distilled from typical specimens of the three species referred to, and consequently there are no chemical data on record with which the results of the work done at the Imperial Institute on the two Cyprus oils can be compared, so that no direct assistance to the settlement of the botanical problem can be given from the chemical side at present.

The results so far obtained in the chemical examination of oils from Origanum species show that the oils are sharply divided into two groups: viz. a group containing either carvacrol or thymol as the chief constituent, and a group containing little or none of either of these phenols. "Cyprus origanum oil" belongs to the first group and contains over 80 per cent. of carvacrol. Cyprus marjoram oil belongs to the second group and contains not more than 2 per cent. of phenols, which have not yet been identified. Three samples of Cyprus marjoram oil have been submitted to preliminary examination at the Imperial Institute since 1909, but the results have not been published hitherto, partly because of the botanical difficulty already alluded to, and partly because the oil is of little commercial interest. It seems desirable, however, to put these results on record now, since they may assist in the clearing up of the difficult botanical problems which the genus Origanum presents.

Examination of Cyprus Marjoram Oil and Herb

Two samples of the oil and one sample of the herb have been received at the Imperial Institute, as well as herbarium specimens of the plant. Part of the latter were submitted to Dr. Stapf, of the Royal Gardens, Kew, for identification, and the remainder were supplied to the Museum of the Pharmaceutical Society, at the request of the Curator, Mr. E. M. Holmes. The identifications given by these authorities have already been quoted.

The two samples of Cyprus marjoram oil were pale yellow in colour; they possessed a pungent taste and a pleasant odour.

The sample of herb consisted mainly of flowers and leaves in broken condition. It also was examined by Dr. Stapf and Mr. Holmes and found by them to consist of the plant represented by the botanical specimens submitted to them. This herb, on distillation in the Imperial Institute laboratories, yielded 3·05 per cent. of oil quite similar in properties to the two oils received from Cyprus, and which had been distilled there by the Agricultural Department of the island. The results of the preliminary examination of these three oils are given in the following table:

	Marjoram oil distilled in Cyprus.		Marjoram oil distilled from the Cyprus herb at the Imperial Institute, 1909.
	Sample No. 1 (1909).	Sample No. 2 (1911).	
Specific gravity at $\frac{15^\circ \text{C.}}{15^\circ \text{C.}}$	0·899	0·9126	0·888
Optical rotation in a 100 mm. tube	+ 14° 2′ at 21° C.	+ 3° 45′	+ 13° 15′ at 20° C.
Saponification value[1]	6·4	8·25	12·8
Saponification value[1] after acetylation	—	71·22	—
Solubility in 80 per cent. alcohol.	Soluble in 1·3 or more volumes.	Soluble in 1 or more volumes	Soluble in 8 to 9 volumes[2]
Percentage absorbed by 5 per cent. solution of caustic soda	—	—	2·0 (by volume)

[1] *Expressed as milligrams of caustic potash per gram of oil.*

[2] *This oil was distilled in* 1909; *on keeping it appears to become more soluble, as it is now* (*March* 1913) *soluble in* 1·4 *or more volumes of* 80 *per cent. alcohol.*

A detailed chemical examination of Cyprus marjoram oil at the Imperial Institute has been delayed by pressure of other work, but the results so far obtained show that the oil is somewhat similar to the "oil of sweet marjoram" described by Biltz in 1899 (*Berichte Deut. Ges.*, 1899, **32**, 995). The oil examined by Biltz was supplied by Schimmel & Co., of Leipzig, and was described as that of *O. majorana*, the plant commonly known as "sweet marjoram." A sample of this oil purchased from Messrs. Schimmel & Co., has been examined at the Imperial Institute, and the results are given in the following table along with those of Biltz, both being compared with a summary of the data afforded by the Cyprus marjoram oil and by oil distilled at the Imperial Institute from sweet marjoram herb of French origin. The French sweet marjoram herb distilled was examined by Mr. Holmes and found to consist of *O. majorana.*

	Results obtained at the Imperial Institute.			Biltz results.
	Cyprus marjoram oil.	Oil distilled from French sweet marjoram herb.[1]	Sweet marjoram oil distilled in Germany.	Sweet marjoram oil distilled in Germany.
Specific gravity at $\frac{15^\circ C.}{15^\circ C.}$ unless otherwise stated.	0·888 to 0·912	0·895	0·901	0·898 at $\frac{14^\circ C.}{14^\circ C.}$
Optical rotation in a 100 mm. tube.	+ 3° 45′ to 14° 2′ at 20 to 21° C.	+ 14° 40′ at 23° C.	+ 17° 1′ at 20° C.	+ 15° 45′ at 15° C.
Saponification value .	6·4 to 12·8	19	21	17
Solubility in 80 per cent. alcohol.	Soluble in 1 or more volumes	Soluble in 1·3 or more volumes	Soluble in 1·1 or more volumes	—
Percentage absorbed by 5 per cent. solution of caustic soda.	0 to 2·0 (by volume)	1·0—2·0 (by volume)	—	—

On the whole the constants of the Cyprus marjoram oil are very similar to those of sweet marjoram oil as distilled in Germany, and as prepared from French sweet marjoram at the Imperial Institute, so that these results support to some extent Stapf's view that the Cyprus marjoram plant is *O. majoranoides* which is sometimes regarded as only a form of "sweet marjoram" (*O. majorana*). The Cyprus oil might very well replace sweet marjoram oil in commerce; but unfortunately the demand for sweet marjoram oil is very small, and consequently it is doubtful whether the distillation of the oil in Cyprus for export would be worth undertaking. Samples of the Cyprus oil were submitted to several firms, and it was ascertained that it might find a market at about 3*s.* to 3*s.* 6*d.* per lb., but that even if it could be sold at this rate the market would not be large.

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[1] *The herb used consisted mostly of leaves, but contained a few flowers; it yielded* 0·3 *to* 0·36 *per cent. of oil in the two small consignments distilled* (*March* 1913).

BEESWAX FROM THE ANGLO-EGYPTIAN SUDAN

In a previous number of this Bulletin (1910, 8, 23) attention was directed to some of the possibilities of an extended export of beeswax from various parts of Africa.

Since then a number of promising samples of this material have been received from the Anglo-Egyptian Sudan, and these are described below.

"Beeswax from Sennar Province." This consisted of a number of circular cakes, flat on the top and rounded on the bottom surface. The upper portions of the cakes were in most cases clean, and of yellowish-brown colour, but the lower portions were dirty, dark greyish-brown, owing to the settling out of dirt as the wax cooled after melting. The wax could be improved in appearance by re-melting and straining.

An average sample of the wax was found to contain 0·66 per cent. of dirt (matter insoluble in carbon tetrachloride) and 0·24 per cent. of ash. The amount of ash in the wax was normal, but the percentage of dirt was too high.

A sample of the wax was submitted for valuation to commercial experts, who stated that the material was dirty, and in this state might not realise more than £6 7*s.* 6*d.* per cwt., but if fairly clean its value would be £6 15*s.* to £6 17*s.* 6*d.* per cwt. ex warehouse, London (September 1911).

"Beeswax from the Yei River District." This sample consisted of a ball of wax, somewhat dirty on the outside, pale coloured, opaque, mottled, and free from obvious impurities.

The wax was submitted for valuation to brokers, who stated that the sample was very clean for rough ball, and worth fully £6 12*s.* 6*d.* per cwt., less 2½ per cent. discount, ex warehouse, London (December 1911). They added that beeswax of this description is easily saleable.

"Beeswax collected near Raga, in the Western District of the Bahr-el-Ghazal Province." This was a portion of a circular cake of pale-coloured wax, about 1¼ in. in thickness, and free from any appreciable amount of dirt except on the exterior. It was of a paler tint than the sample from the Yei River District, and was equally clean.

The wax was submitted to brokers, who valued it at £7 5*s.* per cwt., less 2½ per cent. discount, ex warehouse, London (June 1912). Consignments of similar wax would be readily saleable.

"Beeswax collected in the Yambio District of the Bahr-el-Ghazal Province." Four samples of this product were submitted as follows:

"*A.*—'Light' or 'clear' as brought in." Irregular lumps of pale brown, unmelted wax containing much honey.

"*B.*—'A' after being boiled down to about ⅓ of its original weight." Irregular fragments of yellow wax, about $\frac{5}{16}$ in. thick, covered with mould externally, but clean within.

"*C.*—'Dark' or 'dirty' as brought in." Irregular lumps of dirty, dark brown wax.

"*D.*—'C' after being boiled down to about ¼ of its original weight." Irregular lumps of yellow wax, fairly clean inside, but containing some dirt.

The specimens were examined with the following results:

	A.	B.	C.	D.
	Per cent.	*Per cent.*	*Per cent*	*Per cent*
Moisture	13·4	0·18	18·9	0·3
Dirt (approx.)	9·5	0·34	12·5	1·3
Water-soluble impurities, *i.e.* honey, etc. (approx.)	38·0	0·27	49·5	0·7
Wax (approx.) by difference	39·1	99·2	19·1	97·7

The materials represented by samples A and C could not be offered as beeswax in the United Kingdom. It might be possible to sell such products as raw material for the extraction of wax, but it would be very much better to export clean wax prepared as already described in this BULLETIN (*loc. cit.*).

Beeswax represented by samples B and D would be saleable in the United Kingdom, the former being worth about £6 12*s.* 6*d.* and the latter about £6 10*s.* per cwt., less 2½ per cent. discount (October 1912). Slightly higher prices would be obtainable for the wax if it were shipped quite clean in the form of cakes.

OIL-SEEDS FROM THE ANGLO-EGYPTIAN SUDAN

The production of oil-seeds is one of the most important of the minor industries of the Sudan. In addition to sesamum, which is cultivated largely in the Kassala, Sennar, Kordofan, and the Blue and White Nile Provinces, ground nuts, senat, castor, safflower, and sunflower seeds are grown on a smaller scale, whilst the shea butter tree (*Butyrospermum Parkii*) occurs in many parts of the Bahr-el-Ghazal. The production of castor seed has not yet reached a commercial stage. The seed can be profitably grown in many parts of the Sudan, but the natives have not yet become aware of its value.

An export trade in several of these oil-seeds, as well as cotton seed, has already grown up, the statistics for the last three years for which figures are available being shown in the following table :

	1909.		1910.		1911.	
	cwt.	£	*cwt.*	£	*cwt.*	£
Sesamum . . .	122,640	64,709	116,213	67,717	97,134	73,427
Cotton seed . . .	36,342	9,267	33,643	10,749	139,810	32,406
Ground nuts . . .	5,804	3,688	18,172	8,959	22,100	13,400
Senat seed . . .	—	—	3,463	1,046	447	311

An account of the examination of shea kernels (" Lulu " nuts) and fat and castor seed from the Sudan has already been given in this Bulletin (1908, **6**, 372; 1911, **9**, 26); in the following pages samples of sesamum, castor seed, senat seed, and *Salvadora persica* seeds, which have been received at the Imperial Institute in recent years, are dealt with. For an account of the cultivation and utilisation of sesamum seed, including particulars of the industry in the Sudan, see this Bulletin (1911, **9**, 259).

Sesamum Seed

" Sim-sim (sesame) seed, known locally as 'eirawi,' from the Gedaref district of Kassala Province." This sample consisted of white sesamum seed, mixed with 3·5 to 4·0 per cent. of extraneous matter, which could be removed by sifting. The clean seed contained 4·7 per cent. of moisture, and yielded 51·0 per cent. of oil. This yield of oil is normal and satisfactory. The oil had the usual appearance of sesamum seed oil.

The sample was submitted to brokers, who stated that it was superior to the fair average grade of sesamum seed. They valued it at about £17 per ton delivered to European ports (May 1912), with large white Bombay seed at £19 per ton, and yellow Chinese at £18 *7s. 6d.* per ton.

"'Eirawi' sim-sim seed from the Gedaref district of Kassala Province." This consisted of white seed, mixed with a small quantity of extraneous matter. The clean seed yielded 51·2 per cent. of oil, which is normal and almost identical with the yield from the previous sample from the Gedaref District. The oil possessed the normal characters of sesamum seed oil.

The seed was submitted to brokers, who stated that it was of very good quality and valued it at £17 10*s.* per ton, delivered at European ports (August 1912), with large white Bombay seed at £17 17*s.* 6*d.* per ton.

CASTOR SEED

"Castor Seed from Nahud, Kordofan Province." Large, reddish-brown, mottled seeds, in good condition. A few broken seeds were present in the sample. The seeds yielded 50·5 per cent. of oil, representing a normal yield. The oil had the usual characters of castor oil.

This castor seed would realise about the same price as Bombay castor seed, which was then quoted at £12 per ton in London (September 1911).

"Castor Seed from Mongalla Province." Very small, grey seed, which yielded 43·3 per cent. of oil with the usual characters of castor oil.

The seed was submitted to a firm of oil-seed crushers, who reported that its value (January 1912) would be £10 12*s.* 6*d.* per ton, net weight, including bags, delivered free, ex ship Hull, less 2½ per cent. discount.

A small consignment of castor seed from the Sudan was sold in consultation with the Imperial Institute in

May 1912 at the rate of £12 5*s.* per ton, the current price of Bombay castor seed.

SENAT SEED

The senat plant occurs as a weed in many parts of the Sudan, and is cultivated on a small scale in Central Gezira, and more generally in Managil and Blue Nile Province. Large quantities of the seed might be exported from the Kordofan Province if the cost of transport could be reduced, whilst a considerable quantity would be available also in the Tokar district of the Red Sea Province. Small quantities of the seed were first exported to Marseilles early in 1910, where it sold at about £12 per ton as a substitute for sesamum seed.

The oil expressed from the seed is well known to the natives, who use it for edible purposes. The seeds are also dried and eaten by the people after being crushed, whilst the leaves and fruit cases have been used as a cattle food.

Several forms of the plant are grown in different parts of the Sudan under the following names: "Hameid," "Fagus," "Ajurr," and "Tibish." Botanical specimens of the various forms have been received at the Imperial Institute and were submitted to the Director of the Royal Gardens, Kew, who stated that they all appeared to be cultivated races of *Cucumis Chate*, L. (*C. Melo* var. *agrestis*, Naud.; *C. arenarius*, Schum. et Thonn.). *C. Chate* is said to be indigenous in Egypt, Nubia, and Abyssinia, and Naudin considers it to be the wild type of the cultivated melon.

Six samples of the seed have been examined at the Imperial Institute, with the results given below.

No. 1.—Senat seed. Oval, flat, cream-coloured cucurbitaceous seeds, 0·7 cm. long and 0·35 cm. wide.

No. 2.—"Fagus" seed. This sample resembled No. 1, but was yellower and somewhat flatter.

No. 3.—Senat seed known locally in Kordofan Province as "Tibish." These seeds resembled in appearance the preceding samples, but they were of a greyish colour and somewhat less rounded in shape. The sample was in a dirty condition.

No. 4.—Senat seed from the Kadugli district of the Jebels Sub-Province, Kordofan. This sample resembled the preceding sample of "Tibish" seed, but was not so dirty.

No. 5.—"Hameid" seed. Light brown seeds, resembling senat seeds in shape and general appearance, but only about one-half as large.

No. 6.—Senat seed from Bara, Kordofan Province. Cream-coloured, flat seeds, rather larger than any of the previous specimens.

All the samples yielded a pale yellow liquid oil, free from smell or unpleasant taste. The oils from the various samples of seed were examined, with the results given in the following table, to which are added the figures for oils from other cucurbitaceous seeds.

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	Ikpan seed[3] from Southern Nigeria.	Melon seed (*Cucumis Melo*).	Water-melon seed (*Citrullus vulgaris*).
Yield . . *per cent.*	36·5	31·0	29·5	31·7	30·2	38·4	25·4	43·8	40·8
Specific gravity at $\frac{15·5° C.}{15·5° C.}$	0·923	—	—	0·923	0·925	—	0·918–0·922	—	—
Acid value[1]	1·0	—	—	0·7	0·7	—	1·4–5·5	—	—
Saponification value[1] .	192·0	190·5	189·3	189·2	187·0	—	194–196·5	193·3	189·7
Iodine value . *per cent.*	117·0	121·3	117·0	124·0	128·5	—	106–107	101·5	118
Titer test[2] . . .	30·3° C.	—	—	—	—	—	36° C.	36° C.	32° C.

[1] *Milligrams of potassium hydroxide per gram of fat.*

[2] *Solidifying point of fatty acids.*

[3] *Cf. this* BULLETIN, 1907, **5**, 132; 1908, **6**, 356.

In the case of No. 1 the Hehner value, *i.e.* the percentage of insoluble fatty acids and unsaponifiable matter, was 96·6; the percentage of unsaponifiable matter 0·7; and the Reichert-Meissl value, *i.e.* the quantity of decinormal alkali required to neutralise the volatile acids from 5 grams of fat, nil.

This senat seed oil is similar to the oils derived from other seeds of Cucurbitaceæ, and on account of its pale colour and freedom from smell and taste would be suitable for edible use.

Utilisation of Senat Husks

Senat seeds are contained in a melon-like fruit usually about three inches in length. With a view to ascertaining the possibility of utilising the husk of the senat fruit after the removal of the seeds, samples of entire fruits, broken husks, and powdered husks were forwarded from the Sudan.

The powdered husks were examined in order to ascertain their suitability for use as a feeding stuff. The material was found to have the following percentage composition:

Moisture	10·63
Crude proteins	10·75
Consisting of:	
True proteins	5·43
Other nitrogenous substances	5·32
Fat	2·26
Starch, etc.	38·80
Fibre	20·50
Ash	17·06
Nutrient ratio[1]	1 : 4·1
Food units[2]	71·3

No cyanogenetic glucosides or alkaloids were present.

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[1] *The ratio between the percentage of crude proteins and the sum of the percentages of starch and fat, the latter being first converted into its starch equivalent.*

[2] *The total obtained by adding the percentage of starch to 2·5 times the sum of the percentages of fat and crude proteins.*

The above results show that these senat husks have only a very low feeding value and contain much fibre and mineral matter. It is therefore evident that they would not form a desirable feeding stuff for cattle, except possibly as a diluent for richer materials.

In view of the high percentage of mineral matter (ash), it was thought they might be of value for manurial purposes. In order to determine this point an analysis was made of the ash, which was found to have the following percentage composition:

Lime	CaO	8·42
Magnesia	MgO	4·11
Potash	K_2O	42·69
Soda	Na_2O	0·70
Phosphoric acid	P_2O_5	2.51
Chlorine	Cl	2·08
Sulphuric acid	SO_3	3·85

These figures indicate that the mineral constituents of senat husks should be of value as a manure, particularly for crops requiring potash. It is probable therefore that good results could be obtained by applying the husks direct to the soil as a manure.

SALVADORA PERSICA SEEDS

S. persica, L., is a diffuse shrub or small tree belonging to the natural order Salvadoraceæ, which is found in a wild state throughout the Sudan, where it is known as "mustard tree."

The seeds received at the Imperial Institute were round, averaging about 0·15 in. in diameter, with thin shells of greyish colour, in many cases slightly mottled with brown. The kernels, which were bright yellow, possessed an unpleasant, bitter taste. The seeds yielded 44·6 per cent. of hard, bright yellow fat, with a faint, slightly unpleasant odour.

The fat was examined with the following results, compared with that from the seeds of *S. oleoides* from India:

	Present sample of *S. persica* seeds.	Seeds of *S. oleoides* from India.[1]
Specific gravity at $\frac{99° C.}{15° C.}$	0·867	0·908 (at 50° C.)
Acid value . . .	9·3	11·3
Saponification value .	245·2	242·4
Iodine value, *per cent.* .	5·9	7·5
Titer test	30·4° C. (approx.)	40° C.
Melting-point . . .	38° C.	41° C.

[1] *Figures recorded by Hooper in the Indian "Agricultural Ledger,"* 1908, *No.* 1.

The sample of the seeds was too small for commercial valuation. It may, however, be pointed out that the hardness and high melting-point of the fat render it suitable for the manufacture of candles, and if its unpleasant odour and taste could be removed by purification on a commercial scale it might possibly be employed in the preparation of vegetable butters and "chocolate fats."

In the Indian *Agricultural Ledger*, 1908, No. 1, *S. persica* and *S. oleoides* are considered to be distinct species, but in the *Index Kewensis* they are regarded as identical. The fat extracted from the present sample of seeds resembles that described in the *Agricultural Ledger* as the fat of *S. oleoides*, and as the botanical identity of the Sudan plant would therefore be of interest, specimens have been requested for determination.

"CHEYI" SEED AND FIBRE

THE name "Cheyi" is applied by the natives of Northern Nigeria to *Polygala butyracea*, Heck., a herbaceous plant occurring commonly in tropical West Africa. The seeds of this plant contain a valuable fat which can be utilised for edible purposes, whilst the stems yield a fibre which is used by the natives for making fishing-nets, cloth, thread, etc. A sample of the seed from Northern Nigeria has been received recently at the Imperial Institute, as well as samples of fibre and native-prepared thread. The results of examination of these specimens are given below.

SEED

The sample consisted of flat, oval seeds, about $\frac{1}{8}$ in. long and ^{1} in. broad, brownish-black externally and greenish-yellow within. Some husks and other extraneous matter were present. The seeds yielded 37·9 per cent. of soft, yellowish fat, which possessed a pleasant taste and no distinctive odour.

The fat was examined with the following results, compared with those previously recorded for "Cheyi" fat:

	Present sample.	Results previously recorded.
Melting-point . . .	36° C.	—
Specific gravity at $\frac{100° \text{C.}}{15·5° \text{C.}}$	0·866	—
Acid value[1] . . .	1·24	11·4
Saponification value[1] . .	251·0	253·0
Iodine value, *per cent.* .	52·5	49·4
Titer test[1]	37·85° C.	—
Hehner value,[1] *per cent.* .	85·6	—
Reichert-Meissl value[1] .	45·6	45·5

[1] *For the meaning of these terms, see p.* 59.

The fat contained 0·55 per cent. of unsaponifiable matter.

Samples of the seeds were submitted for valuation to makers of edible fats and to oil-seed crushers, who furnished the following reports:

(1) The makers of edible fats were of opinion that "Cheyi" fat would be very suitable for their purposes if the seed arrived in the United Kingdom in good condition, and were proved to contain no poisonous constituents. On the basis of the yield of fat, they valued the seeds at about half the price of copra, which is now selling in the United Kingdom at £27 15*s.* to £29 10*s.* per ton (March 1913).

(2) The oil-seed crushers also regarded the seed and fat as likely to be of considerable commercial value. They were of opinion that the fat should eventually realise a good price for edible purposes. Assuming that the residual cake would be suitable for feeding cattle, a point that will have to be determined by trial, they considered the seed to be worth at least £12 per ton in the United Kingdom, and expressed a desire to receive a trial consignment of 100 tons, at this price, as a commencement.

FIBRE

The sample consisted of strands of fibre somewhat resembling hemp in appearance, and varying in colour from pale yellow to brown. It was of good strength, and varied in length from 2 ft. to 4 ft., but was mostly between 3 ft. and 4 ft.

The fibre was examined with the following results, compared with Sunn hemp from India:

	Present sample.	Sunn hemp (*Crotalaria juncea*) from India.
	Per cent.	*Per cent.*
Moisture	8·5	7·5
Ash	3·5	2·0
α-Hydrolysis, loss	21·7	17·9
β-Hydrolysis, loss	27·6	27·4
Acid purification, loss	5·7	3·6
Cellulose	69·9	75·6
Length of ultimate fibres	0·6 to 1·3 in.	0·08 to 0·4 in.

It was considered by experts to be equal in value to fine Bombay hemp (*Crotalaria juncea*), which was quoted in London at £26 to £27 per ton (April 1912). This price was unusually high, owing to a deficiency in the supply of true hemp and the existence of a large demand; the normal value is about £17 to £18 per ton.

The results of the chemical examination indicate that this fibre somewhat resembles Sunn hemp of similar appearance and quality in its behaviour towards dilute alkali (α- and β-hydrolysis), but that it contains a lower percentage of cellulose, and might therefore be rather less durable. On the other hand, the ultimate fibres of which the Polygala fibre is composed are much longer than those of Sunn hemp, and about equal to the average length of those of true hemp (*Cannabis sativa*).

The commercial experts to whom the fibre was submitted reported that it was very strong and clean, and that it resembled Bombay hemp, but was rather shorter. They regarded it as a soft roping hemp of useful quality, but pointed out that a small proportion of the fibre was of dark colour and very weak.

There seems no doubt that fibre of the quality of this sample would be readily saleable in large quantities in the United Kingdom as a substitute for hemp, and enquiries are being made as to whether it could be produced in Northern Nigeria on a sufficiently large scale for export.

NATIVE-PREPARED THREAD

The sample was prepared from fibre grown in Kupa district, Kabba Province, Northern Nigeria. It consisted of two hanks of an unevenly spun thread or yarn, which had been made by twisting together the ultimate fibres of a non-lignified material somewhat resembling flax and ramie.

The ultimate fibres composing the thread had an average length of about 1·5 in., and an average diameter of about 0·00114 in. They were of fairly regular diameter, and exhibited transverse markings and knot-like joints similar to those of flax; the markings, however, were not always well developed. In many cases a narrow lumen was present. The fibre was fairly strong, but lacking in elasticity.

"Cheyi" fibre, in the condition represented by the material of which this thread was composed, might possibly be of commercial value in the United Kingdom for spinning purposes, if obtainable in large quantities and at a price which would enable it to compete with cotton and flax. The fibre, however, was much less elastic than cotton, and lacked the peculiar spirally twisted structure to which the spinning properties of the latter are due. For this reason it is somewhat doubtful whether the fibres would cohere sufficiently to permit of their being spun by the ordinary cotton-spinning machinery. Moreover, "cheyi" fibre does not possess the advantage of length which enables flax to be spun. Flax fibre consists of strands averaging 20 in. in length, whilst the ultimate fibres of *Polygala butyracea*, which alone could be employed for spinning, are only about 1½ in. long.

ZAPUPE FIBRE

Considerable interest has been taken in recent years in Zapupe fibre, which has been introduced into commerce as a substitute for Sisal hemp. As in the case of the latter fibre, Zapupe is obtained from the leaves of certain species of Agave, but the exact botanical source is unknown. The plant occurs wild in the State of Vera Cruz, Mexico, and has been cultivated in the Canton of Tuxpam in that State since about 1901 or 1902. The plant is stated to give better results under varied conditions of soil and climate than Sisal, and as it requires little attention in cultivation it seems probable that, once its value is known, its cultivation will be taken up in other countries.

The best situations for the cultivation of Zapupe are gently sloping plains, or the lower slopes of mountains, with a fairly rich soil of not too porous a nature. As the plant is essentially tropical, it will not flourish at high altitudes. It is usually propagated by means of suckers which are removed from the parent plant when a few inches high, and planted in specially prepared nurseries. After about eight to ten months the plants, now 1 or 2 ft. high, are removed to their permanent quarters and set in rows 7 ft. apart, with a distance of 5 ft. between the plants.

The cutting of the leaves is begun when the plants are four or five years old, and may be continued for a period of about eight or ten years, when the plant produces a large inflorescence, bearing numerous bulbils, which may be used for propagation. An average of about eighty leaves, giving a total yield of about 2½ lb. of fibre, is obtained per annum from each plant in three cuttings.

Two samples of Zapupe fibre have been examined recently at the Imperial Institute, with the results given below:

No. 1.—This sample consisted of well-cleaned and well-prepared, lustrous fibre, almost white, and of good strength. The length of staple was irregular, in some cases reaching 4 ft. 8 in.

The fibre was analysed with the following results, compared with corresponding figures for Mauritius hemp and for Sisal hemp from the East Africa Protectorate:

	Zapupe fibre. *Per cent.*	Mauritius hemp. *Per cent.*	Sisal hemp. *Per cent.*
Moisture	11·2	13·0	11·1
Ash	1·2	2·5	1·0
α-Hydrolysis, loss	11·8	7·5	11·2
β-Hydrolysis, loss	15·7	18·3	14·1
Acid purification, loss	2·7	2·0	2·3
Cellulose	77·3	76·4	78·2
Length of ultimate fibres	From 0·05 to 0·14 in.; average 0·094 in.	From 0·05 to 0·15 in.	From 0·06 to 0·16 in.

It is evident from these figures that the Zapupe fibre approximated very closely to Sisal hemp in chemical behaviour and composition, and that it was somewhat superior to the sample of Mauritius hemp with which it was compared, this superiority being shown particularly by the smaller loss on β-hydrolysis (*i.e.* boiling for one hour with 1 per cent. caustic alkali).

No. 2.—This sample consisted of strong, lustrous, well-cleaned, and well-prepared fibre, of rather irregular colour, varying from cream to brownish-yellow, and generally darker than sample 1. The length of staple was irregular, up to as much as 4 ft. 4 in. This sample was not submitted to chemical examination.

The specimens were submitted to a firm of fibre merchants, who stated that they had not previously seen such good specimens of Zapupe fibre, adding that the samples were of good growth and especially well prepared. They valued No. 1 at about £32 and No. 2 at £30 per ton in London (January 1913), with Mexican Sisal at £34, and best quality Mauritius hemp at £28 to £30 per ton.

This Zapupe fibre should always be readily saleable in the United Kingdom, but the valuations given above are considerably higher than usual, owing to the recent increase in the price of Sisal and other cordage fibres.

"CABBAGE TREE" FIBRE FROM NEW ZEALAND

A SAMPLE of "cabbage tree" fibre was received recently at the Imperial Institute from New Zealand for examination. No information was supplied as to the botanical origin of the fibre, but according to Cheeseman (*Flora of New Zealand*) the name "cabbage tree" is applied to *Cordyline australis*, and the present sample of fibre was probably from that source. It was fairly well prepared, but rather pulpy, of poor lustre, harsh, and somewhat brittle. The colour was uneven, being mostly deep cream, whilst some portions of the sample were greenish. The fibre was of irregular strength, most of it being strong, but some parts weak, especially at the ends. The length varied from 1 ft. 5 in. to 2 ft. 10 in., being mostly from 2 ft. 3 in. to 2 ft. 6 in.

The fibre, after hackling, was analysed with the following results:

	Per cent.
Moisture	13·8
Ash	1·0
α-Hydrolysis, loss	20·3
β-Hydrolysis, loss	22·5
Acid purification, loss	5·4
Cellulose	69·5
Length of ultimate fibres	From 0·03 to 0·32 in.; average, 0·13 in.

The fibre was submitted to brokers, who stated that if it were 3 to 4 ft. in length it would be worth £25 per ton in

London (November 1912), with Mexican Sisal at £34 per ton.

From the appearance of this sample of "cabbage tree" fibre, and from the loss which it underwent on acid purification, it is evident that it had been insufficiently cleaned. The rather low percentage of cellulose and the loss on a-hydrolysis (*i.e.* boiling for five minutes with 1 per cent. alkali) were probably largely due to the same cause.

The comparatively small difference between the losses on a- and β-hydrolysis (the latter being the process of boiling the fibre for one hour with 1 per cent. alkali) indicates that the actual fibre substance was not readily attacked by dilute alkali, and that it would probably be very resistant to the prolonged action of water. The fibre could therefore be used for rope-making purposes, but in order to realise good prices it should be at least 3½ to 4 ft. in length.

"ELEPHANT GRASS" AS A PAPER-MAKING MATERIAL

"ELEPHANT grass" (*Pennisetum purpureum*, Schum. = *P. Benthamii*, Steud.) is a perennial grass growing usually to a height of 6 to 10 ft., and occasionally, on rich marshland, up to 20 ft. It occurs in a wide zone across tropical Africa extending from 10° N. Lat. to 9° S. Lat. on the west coast, and from 9° to 20° S. Lat. on the east coast. It is found chiefly along watercourses and in marshy depressions, but also grows in the more open parts of the bush and forest. In the delta of the Zambesi and along the Shire river it forms extensive reed jungles. The grass has been recommended as a green fodder (see *Kew Bulletin*, 1912, p. 309); it is resistant to drought, and is said to remain green late into the autumn in Rhodesia, and to withstand frost to a remarkable degree. Both cattle and horses eat it readily.

A sample of the dried mature grass was sent to the Imperial Institute recently from Uganda, with a view to ascertaining its suitability for paper-making. The Chief Forestry Officer stated that the grass is a source of great annoyance and expense to agriculturists in that Protectorate, as it grows with great rapidity after the aerial shoots have been either burnt or cut down, but that if it could be profitably used for the manufacture of paper a new and large industry could be built up.

The consignment, which weighed 177 lb. when received at the Imperial Institute, consisted of two bundles of yellow, bamboo-like stems measuring up to 11 ft. in length, with nodes at intervals of a few inches; the diameter of the stems at the base was about 1 inch. Towards the tips the stems bore small branches and thin papery leaf-sheaths.

The stems in the interior of the bundles were moist and mouldy on arrival, and they were therefore spread out and air-dried. After drying in this way the consignment weighed 145 lb.

The air-dried stems were examined with the following results, compared with corresponding figures recorded for Algerian esparto grass and for bamboo:

	"Elephant grass."	Algerian esparto grass.	Bamboo.
	Per cent.	*Per cent.*	*Per cent.*
Moisture on drying at 100°–110° C.	10·7	8·8	10
Ash expressed on the dried material	5·1	3·0	5
Unbleached pulp:			
Expressed on material as received	23·9	—	—
Expressed on air-dried material	29·0	29·5	32 to 42
Expressed on material dried at 100°-110° C. . .	32·5	32·3	—
Length of ultimate fibres	0·05 to 0·14 in.; average 0·08 in.	0·012 to 0·12 in.; average 0·045 in.	0·024 to 0·16 in.; average 0·096 in.

The pulp was of good colour, and was composed, as indicated above, of ultimate fibres rather longer than those of esparto grass, and of about the same length as those of bamboo pulp. It furnished a fairly good paper.

In preparing pulp from this "elephant grass" at the Imperial Institute no difficulty was occasioned by the nodes, so that it should not be necessary to cut these out when utilising the stems for paper-making, as is sometimes recommended in the case of bamboo (compare this Bulletin, 1912, **10**, 676.) It may, however, be mentioned that the nodes are stated to have caused some difficulty in trials carried out in Germany with "elephant grass" from Togoland.

On account of the light and bulky nature of "elephant grass" it is very unlikely that the stems could be profitably shipped to Europe for paper-making, as they would probably only realise about the same price as esparto grass of average quality, viz. *£3 7s. 6d.* per ton (February 1913). If, however, the stems were converted into pulp in Uganda by treatment with caustic soda, it is possible that a remunerative industry might be carried on, since the pulp would probably be of approximately the same value for paper-making as wood pulp prepared by the soda process, viz. *£7 10s.* to *£8 12s. 6d.* per ton in London (February 1913).

THE COTTON INDUSTRY OF NORTHERN NIGERIA

Cotton has long been cultivated by the natives of Northern Nigeria, and the markets in the more northern parts have been frequently visited by caravans from North Africa in order to obtain the cotton used in the weaving industry of that part of the continent. Hitherto transport difficulties have prevented the cotton of the northern districts being exported to the United Kingdom, but the completion of the Baro-Kano railway will enable this vast and populous area to be tapped. Up to the present the efforts to encourage cotton cultivation amongst the natives have been confined to the Niger and Benue valleys, and with this end in view the British Cotton Growing Association erected ginneries at Lokoja, at the junction of the Benue and Niger rivers, and at Ogudu on the Niger, in the Ilorin Province. More recently a large ginnery has been erected at Zaria, further north. The Ogudu ginnery, however, was closed on the opening of the Lagos Government Railway, the cotton from this district being ginned in Southern Nigeria.

In the Kano and other northern districts the indigenous cotton is short-stapled with white lint, whilst that of the Benue and Niger valleys is long-stapled with tinted lint. Plantations have been formed by the British Cotton Growing Association at Lokoja and Ogudu, where experimental work has been carried out on the acclimatisation of exotic seed, selection of native seed and varieties, rotation of crops, time of planting, comparative tests of varieties, cultivation by draught animals, etc. Exotic cottons have also been experimentally cultivated at some of the gaol farms.

Complete statistics of the exports of cotton from Northern Nigeria are not available, but some idea of the production may be gained from the following figures, showing the quantity of unginned cotton purchased by the British Cotton Growing Association and by merchants in recent years:

	Tons.
1904 . . .	156
1905-6 . . .	362
1907 . . .	368
1908 . . .	152
1909 . . .	375
1910 . . .	111
1911 . . .	230

A large number of samples of cotton, chiefly indigenous varieties, from Northern Nigeria, have been examined at the Imperial Institute, and an account of the results of examination of the earlier samples will be found in this Bulletin (1909, **7**, 158), and in *British Cotton Cultivation*, by Prof. Wyndham Dunstan, *Colonial Reports, Miscellaneous Series*, No. 50 [Cd. 3997], 1908, whilst a description of the native cotton industry of the Protectorate has been published in this Bulletin (1905, **3**, 50). The samples received in recent years are dealt with in the following pages.

Indigenous Cottons

No. 1—Munshi Cotton, Doma Section. This sample of seed-cotton yielded on ginning 35 per cent. of lint, the yield per 100 seeds being 5·16 grams. The lint was fairly soft, lustrous, and of an even cream colour, with very occasional reddish-brown stains. The seeds were of medium size, smooth and dark brown in colour, with light brown tufts at the pointed ends; 13 per cent. of the seeds examined were withered, and would be useless for sowing.

The cotton was of normal strength, and varied in length from 1·1 to 1·3 in., the diameter ranging from 0·0006 to 0·0011 in., with an average of 0·00081 in.

Although this cotton was somewhat harsher than American Upland, it was of good quality, and would no doubt be useful as a medium staple cotton, with applications similar to those of Upland varieties. It was valued at about 5⅜*d.* per lb. (ginned), with "middling" American at 6·56*d.* per lb.

No. 2.—Native Nupe. This was grown at the Government Experimental Farm, Baro, and consisted of ginned cotton, soft and fairly lustrous, but stained to such an extent as to be almost of uniform reddish-brown colour. The strength of the cotton was uneven, some portions being very weak. The length varied from 1·0 to 1·3 in., and the diameter ranged from 0·0005 to 0·0011 in., with an average of 0·00074 in.

The nominal value of this cotton was 4½*d.* to 5*d.* per lb., with "middling" American at 6·55*d.* per lb., but although valued at only 1½*d.* to 2*d.* per lb. below "middling" American cotton, it is doubtful whether material such as represented by this sample would be of any commercial utility. The colour of the cotton suggested that it had suffered greatly from the attacks of insect pests, followed by exposure to the weather.

This experiment in cotton-growing at Baro is referred to by the Inspector of Agriculture in his Third Report (1909) on the Agricultural and Forest Products of Northern Nigeria, in the following terms:

"It appeared that the plot irrigated at Baro had been planted too late, as the plants were commencing to fruit at the beginning of May, when the heavy showers which occurred induced them to produce a useless growth of leaf at the expense of bolls. The fruiting might possibly have been accelerated by the stoppage of irrigation when the first bolls had formed, and by the subsequent supply of very small quantities of water only, as each new series commenced to form."

No. 3.—This sample of native seed-cotton yielded on ginning 32·5 per cent. of lint, the yield per 100 seeds being 4·2 grams. The lint was fairly soft and lustrous, mixed in colour, varying from pale reddish-brown to white, with some brown and occasional bright red stains. The seeds were of average size, closely covered with a thick down, and varying in colour from light-brown to greenish-brown; 20 per cent. of the seeds examined were withered and would be useless for sowing.

The cotton was of normal strength, and varied in length from 0·8 to 1·1 in., the diameter ranging from 0·0005 to 0·0010 in., with an average of 0·00081 in.

The ginned cotton was worth about 7¼*d.* per lb., with "fully good fair" brown Egyptian cotton at 11⅝*d.* per lb., and "middling" American at 7·59*d.* per lb. It was of somewhat poor quality, being short in staple and uneven in colour; on ginning, the brown and white cotton became mixed, when the whole somewhat resembled brown Egyptian cotton. Its market value should therefore be regarded as that of a low quality of Egyptian cotton rather than American Upland, although its shortness would render it more suitable for use as a substitute for Upland than for Egyptian cotton. The stains on the cotton indicated the presence in the crop of insect pests, probably of *Dysdercus* sp.

No. 4.—Cotton from Keffi Division, Nassarawa Province. This sample of seed-cotton yielded on ginning 30 per cent. of lint, the yield per 100 seeds being 3·5 grams. The lint was soft, fairly lustrous, and of deep cream colour, with a rather large quantity of reddish-brown stains. The seeds were of medium size, and generally closely covered with a short greenish-brown or white down. Occasional smooth brown seeds were also present; 20 per cent. of the seeds examined were withered and would be useless for sowing.

The cotton was of uneven strength, some portions being rather weak. The length varied from 0·9 to 1·3 in., and the diameter ranged from 0·0005 to 0·0012 in., with an average of 0·00079 in.

The value of the ginned cotton was about 7*d.* per lb., with "middling" American at 8·04*d.* per lb. It was of fairly good quality, but was depreciated in value by the presence of stains which appeared to have been caused by insect pests in the crop. Greater care in cultivation would no doubt result in the production of a superior type of cotton, and one which would meet with a ready sale in the United Kingdom.

No. 5.—Cotton from Illushi. This cotton was somewhat harsh, fairly lustrous, and of deep cream colour with occasional small brown and pale yellow stains. The strength was generally normal, but some portions were weak. It varied in length from 0·8 to 1·5 in., but was mostly between 1·0 and 1·2 in. The diameter ranged from 0·0006 to 0·0012 in., with an average of 0·0009 in. The material is thus somewhat coarser than American Upland cotton.

This cotton was of very good quality and readily saleable in the English market. It was valued at about 1*d.* per lb. in advance of "middling" American. The cultivation of this variety might well be extended, as the product is much superior to most of the cotton grown in West Africa.

No. 6.—Four samples of "Bassa" seed-cotton grown at the Zungeru Prison Farm, at different distances apart, gave the following yields of lint on ginning:

Spacing	2 ft. × 2 ft.	2 ft. × 3 ft.	3 ft. × 3 ft.	4 ft. × 3 ft.
Yield, *per cent.* . .	33·0	32·8	33·1	33·9
Yield per 100 seeds, *grams*	4·44	4·48	4·89	4·88

The lint of all the samples was clean, fairly soft, of rather dull appearance, and of cream colour with occasional brown and yellow stains. The seeds were of varying size and character, some being covered with white or green fuzz, whilst others were smooth and dark brown; about 20 per cent. of the seeds examined were defective, some being withered or mouldy and others attacked by insects.

The cotton was of good strength but somewhat irregular in length, varying from 1·0 to 1·5 in., but mostly about 1·1 to 1·3 in. The diameter ranged from 0·00065 to 0·0011 in., with an average of 0·00080 in.

The ginned cotton was valued at 8·06*d.* per lb., with "middling" American at 7·96*d.* per lb. It was of useful quality, but its value would have been higher if it had been of brighter appearance and free from stains. The different spacing of the plants does not appear to have produced any difference in the quality of the cotton, as the four samples were practically indistinguishable from one another.

No. 7.—Two samples of "Ilorin" seed-cotton, also grown at the Zungeru Prison Farm, at different distances apart, gave the following yields of lint on ginning:

Spacing	2 ft. × 2 ft.	3 ft. × 2 ft.
Yield, *per cent.*	31·0	31·4
Yield per 100 seeds, *grams*	4·06	3·95

The lint of both samples was clean, fairly soft, of rather dull appearance, and of cream colour with occasional pale brown stains. The seeds were of medium size, and rather varied, being in most cases covered with white, green, or brown fuzz, whilst some seeds were dark brown and smooth; about 20 per cent. of the seeds examined were defective, some being withered and mouldy, whilst others had been attacked by insects.

The strength of the cotton was good, but the length rather irregular, varying from 1·0 to 1·5 in., but mostly from 1·1 to 1·3 in. The diameter ranged from 0·00065 to 0·0010 in., with an average of 0·00079 in.

This cotton closely resembles that of the Bassa variety (No. 6), and was valued at the same price. The two samples were indistinguishable from one another, so that in this case also the spacing of the plants does not seem to have affected the quality of the product.

Both the Bassa and Ilorin cottons were of useful quality and would be readily saleable.

No. 8.—Two samples of native cotton, grown on prepared ground at Zungeru Government House, were received. In one case the ground had been manured, and in the other it had not. They gave the following yields of lint on ginning:

	Manured.	Unmanured.
Yield, *per cent.*	32·5	30·01
Yield per 100 seeds, *grams*	4·49	4·52

The lint of both samples was clean, fairly soft, rather lacking in lustre, and of cream colour with occasional stains. The seeds were fairly large and varied, some being coated with white, brown, or green fuzz, whilst others were smooth, dark brown, or black, with a tuft of fuzz at one end; about 20 per cent. of the seeds examined were defective, being withered, mouldy, or attacked by insects.

The cotton was of good strength, but the length was irregular, varying from 1 in. to 1·7 in., but was mostly about 1·2 to 1·5 in. The diameter ranged from 0·0006 to 0·0010 in., with an average of 0·00080 in.

This cotton was very similar to the Bassa and Ilorin varieties (Nos. 6, 7), and was valued at the same price. The effect of manuring is not apparent in the quality of the first sample as compared with the second, but it may possibly have increased the yield.

No. 9.—This sample from the Muri Province consisted of clean, coarse, rough, curly, lustrous cotton, white and free from stains. It was of good strength, and varied in length from 0·9 to 1·3 in., but was mostly from 1·0 to 1·2 in.

This cotton was valued at about 9·10*d.* per lb., with "middling" American at 8·37*d.* per lb., and "good" moderately rough Peruvian at 10·50*d.* per lb. It was of excellent quality, and somewhat resembled rough Peruvian in character, but was shorter. It would probably be useful for mixing with wool in the production of "union" yarns.

No. 10.—"Matankanawa" seed-cotton from Kazaure, Kano Province. Two leaves of the plant were forwarded with the sample. The lint obtained on ginning was clean, moderately lustrous, fairly soft, greyish-white, and free from stains. The seeds were of medium size, and coated with a green or brown fuzz.

The cotton was of fair strength, and varied in length from 0·7 to 1·3 in., but was mostly from 0·9 to 1·1 in. The diameter ranged from 0·0005 to 0·0009 in., with an average of 0·00073 in.

The nominal value of the cotton was about the same as "middling" American cotton, which at the time of the report was quoted at 6·62*d.* per lb. in Liverpool (April 1912).

This cotton is a form of *Gossypium arboreum*, Linn. In the absence of flowers it was not possible to identify the variety, but it seems not improbable that it may be the form known as *G. arboreum*, Linn., var. *sanguinea*, Watt, which has been previously observed by Dudgeon in Southern Nigeria and the Bassa Province of Northern Nigeria (see p. 16 of *Papers and Reports on Cotton Cultivation*, presented to the International Congress of Tropical Agriculture, held at Brussels in May 1910).

The cotton was of good, useful character, but the colour was rather unsatisfactory. It is probable that it could be improved by cultivation.

No. 11.—Tree cotton found at Kpada, near Egga. This sample of seed-cotton yields a clean, fairly lustrous lint, rather harsh, white, and free from stains. The seeds were small, and covered with a green fuzz.

The strength of the cotton was fairly good, but somewhat uneven. The length varied from 0·7 to 1·1 in., and the diameter ranged from 0·0006 to 0·0012 in., with an average of 0·00084 in.

In general appearance this cotton somewhat resembled the preceding sample of "Matankanawa" cotton, and botanical specimens which accompanied it have been identified at Kew as belonging to the same species, *G. arboreum*, Linn. It was not quite so long as the cotton from Kazaure, and was decidedly coarser; like the latter, however, it was of useful character, and could probably be much improved by cultivation.

No. 12.—Native cotton (*G. peruvianum*) from Ilorin. This seed-cotton yielded on ginning 33·2 per cent. of lint, the yield per 100 seeds being 4·0 grams. The lint was rather dusty, fairly soft, fine, of poor lustre and irregular colour, varying from dark reddish-brown to almost white, with a large number of yellow stains. The seeds were of medium size, some being chocolate brown in colour, bearing no fuzz, and others covered with a green or brown fuzz of medium length. The strength was irregular, but fairly good on the whole. The length varied from 0·8 to 1·4 in., but was mostly from 1·0 to 1·2 in.

The ginned cotton was valued at 6·00*d.* per lb., with "middling" American cotton at 6·60*d.* per lb. It was of promising quality on the whole, but was of mixed and irregular staple. The characters of both seed and lint suggested that the product was derived from plants of more than one variety. It is not unlikely that by making a selection from the best plants in the field a useful and valuable form of cotton might be established.

Improved American Upland Cottons

No. 13.—Two samples of Nyasaland Upland seed-cotton, grown at different distances apart at the Zungeru Prison Farm, were examined. They gave the following yields of lint on ginning:

Spacing	2 ft. × 2 ft.	3 ft. × 2 ft.
Yield, *per cent.* . . .	31·7	31·7
Yield per 100 seeds, *grams* .	3·82	3·80

The lint in each case was clean, soft, lustrous, and white to pale cream in colour, with occasional stains. The seeds were of medium size, and covered with fuzz which was in most cases white, but occasionally green. About 20 per cent. of the seeds examined were defective, some being withered or mouldy and a small proportion attacked by insects.

The strength of the cotton was uneven and the length rather irregular, varying from 1·0 to 1·5 in., but mostly 1·1 to 1·3 in. The diameter ranged from 0·0006 to 0·0010 in., with an average of 0·00075 in.

The ginned cotton was valued at 8·10*d.* per lb., with "middling" American at 7·96*d.* per lb.

These two samples were exactly alike, and were of good quality, but somewhat irregular in length and strength. These defects were probably due to some of the cotton having been gathered before it was quite ripe. If it is intended to grow this cotton on a commercial scale in Northern Nigeria, considerable care will be required in acclimatising and establishing it. In this connection reference should be made to the recommendations of the Director of the Department of Agriculture in Nyasaland in his Report for 1910 (see this BULLETIN, 1910, **8**, 372).

No. 14.—Allen's Improved seed-cotton, grown by the Agricultural Department at Bida. This sample yielded on ginning 30·0 per cent. of lint, the yield per 100 seeds being 4·06 grams. The lint was clean, soft, silky, fine, lustrous, of pale cream colour, almost white, with a few small yellow or brownish stains. Some portions of the sample were immature. The seeds were of medium size, and covered with a white, greenish, or brownish, fairly long fuzz.

The strength of the cotton was irregular, but fair on the whole. Some weak, immature cotton was present. The length was also irregular, varying from 0·7 to 1·5 in.

The ginned cotton was valued at 9*d.* per lb., with "middling" American cotton at 6·60*d.* and "fully good fair" Abassi cotton at 10¾*d.* per lb.

This cotton, whilst maintaining the usual characters of the "Allen's Improved" variety, had apparently suffered from being grown in a new country. It was stated that the seed had been sown too late, and this no doubt would account for the fact that a small proportion of the fibre had not ripened properly, and that in consequence the sample was rather uneven both in length and strength. The result of the experiment, however, was regarded as sufficiently encouraging to warrant its continuance with a view to the acclimatisation of the variety.

SOME FLOSSES OR SILK-COTTONS

Considerable interest has been taken in recent years in the utilisation of flosses or silk-cottons, which consist of the soft, silky hairs attached to the seeds or inner walls of the seed-capsules of many plants belonging to the Malvaceæ, Apocynaceæ, Asclepiadaceæ, etc. The most important of these is kapok, derived from *Eriodendron anfractuosum*, DC. (Malvaceæ), of which an account has already been given in this Bulletin (1911, **9**, 121). Kapok is chiefly used at the present time as a stuffing material in upholstery, but machinery has been devised for spinning this and similar flosses (see this BULLETIN, 1911, 9, 70), and there should be an increased demand for such materials in the future. In the following pages an account is given of the examination of various flosses received in recent years at the Imperial Institute.

KAPOK FROM THE FEDERATED MALAY STATES

The sample was clean, of light brown or yellow colour, very soft to the touch, slightly wavy, of silky lustre, and 0·6 to 1·0 in. long. On microscopical examination, the fibre was found to be very smooth, transparent, and of irregular diameter, varying from 0·0006 to 0·0012 in.

On chemical examination the following results were obtained, which are compared with those furnished by a commercial sample of Java kapok:

	Present sample. *Per cent.*	Java kapok. *Per cent.*
Moisture	8·1	10·9
Ash	1·6	1·3
Cellulose	60·5	64·3

It is evident from these results that the floss was very similar in chemical composition to Java kapok, but contained a somewhat smaller percentage of cellulose. It was also of darker colour and somewhat less lustrous than the standard commercial sample of kapok with which it was compared, but was of approximately the same length.

Commercial experts who examined the sample reported that it was of good quality, clean, of fair colour, rather short, curly, much superior to ordinary Indian kapok, and also better than the Ceylon variety. They added that if the product could be shipped in fair quantities, say 50 or 100 bales of about 160 lb. each, it would probably be saleable in the London market at a price a little higher than ordinary Indian kapok, which is at present worth about 6½*d.* to 7⅝*d.* per lb. (January 1913).

The opinion was expressed that the material would make a better filling for upholstery purposes than the ordinary Indian product, and would be preferred by buyers.

KAPOK FROM BRITISH HONDURAS

This sample consisted of fairly lustrous, soft, dark grey floss, mixed with a large proportion of seed and some capsules and pieces of twigs and branches.

The resiliency of the floss appeared to be about equal to that of ordinary Java kapok. The length of fibre was from 0·6 to 0·9 in.

The material was submitted to commercial experts, who considered that, owing to the dark grey colour of the sample and the high percentage of seed which it contained, its value would not be more than about 2¼*d.* to 2½*d.* per lb. in London (August 1911). They added, however, that it is very difficult to value exactly a small quantity, and expressed a wish to receive a sample of 1 cwt. for thorough trial.

A second firm stated they could use this kapok if obtainable at a suitable price, and they considered that it might realise 3*d.* per lb. in London, or possibly a little more.

This kapok was of low commercial value owing to its poor colour and to the large percentage of seed present. It would be of interest to learn whether the kapok produced in British Honduras is always grey in colour, or whether it can be obtained bright and glossy like Java kapok.

ASCLEPIAS FRUTICOSA FLOSS FROM THE TRANSVAAL

The sample consisted of a lustrous, very pale yellow floss, resembling thistledown in appearance. The material was lacking in resiliency. A considerable proportion of seeds, capsules, and pieces of twig was present.

The yield of fibre obtained on passing the sample through a roller cotton gin was only about 28 per cent. The ginned product still contained a small quantity of fragments of capsules.

The material was weak and brittle, as is usually the case with floss, but its strength was about equal to that of Java kapok. The length of the fibres varied from 0·7 to 1 in.

This floss could probably be utilised as a stuffing material in upholstery, but it would not be so valuable for this purpose as kapok, as it is much less resilient than the latter. From the reports of brokers to whom samples of ginned and unginned floss were submitted it appeared that the material as received from South Africa would only have a nominal value of ½*d.* or 1*d.* per lb. in London, but that the ginned product should realise 2¼*d.* to 4½*d.* per lb., with Java kapok at 8½*d.* to 9½*d.* per lb. and Calcutta kapok at 5*d.* to 5¾*d.* per lb. (December 1911). For upholstery purposes the floss would have to be freed from the seeds, but this could probably be effected by treating it in one of the machines specially designed for cleaning kapok. This latter point could, however, not be determined with the small quantity of floss available at the Imperial Institute.

The material was also submitted to a German firm who have devised a special process for spinning flosses. This firm stated that the Asclepias floss would be quite suitable for their purpose, and that they could probably purchase large quantities of it in the raw, unginned state. The precise value of the material could not be ascertained without technical trials, but would probably be under 2½*d.* per lb. The firm expressed a desire to receive a few bales of the floss in order to carry out a trial with it and report definitely as to its value.

This Asclepias floss from South Africa would probably find a market as a substitute for kapok in upholstery, and could also be utilised for spinning. Technical trials would, however, be required to determine its precise value for these purposes.

ASCLEPIAS SEMILUNATA FLOSS FROM UGANDA

The sample consisted of soft, lustrous, and fairly resilient fibre. It was generally of an even pale yellow colour, but some dark brown stained portions were also present. The floss contained a large quantity of small dark brown seeds, of somewhat irregular shape. The strength was rather poor, as is usually the case with flosses, and the length of staple varied from 1·0 to 1·6 in.

This floss was superior to that of *A. fruticosa* (*see above*), and would have a slightly higher value.

CRYPTOLEPIS FLOSS FROM RHODESIA

This sample of floss was stated to be derived from a plant growing wild in North Western Rhodesia and known as "Kawulembi." Herbarium specimens of the plant were received along with the floss and identified at Kew as a species of Cryptolepis, probably *C. oblongifolia*, Schltr. (Asclepiadaceæ), but flowering specimens would be required to establish the exact identity.

The floss was clean, pale yellowish-brown in colour, very lustrous, straight, and soft to the touch. The strength was fairly good for material of this kind. The fibres varied in length from 1·0 to 1·25 in. and in diameter from 0·0008 to 0·0014 in., with an average of 0·0010 in.

This material could be used as a stuffing material for upholstery, but would be of less value than kapok for this purpose, since the straightness of the fibre, judging from the present sample, would cause a lack of resiliency, which is one of the most desirable properties of an upholstery material and one possessed to a large extent by kapok on account of the curly or waved nature of its fibres.

M'ZIMBITI TIMBER FROM MOZAMBIQUE

"M'ZIMBITI" or "Makruss" timber is the product of a tree, *Androstachys Johnsonii*, Prain, belonging to the Euphorbiaceæ. According to W. H. Johnson, late Director of Agriculture in the territories of the Mozambique Company, the tree is abundant in the low country of the Manica and Sofala territories, Mozambique, but appears to flourish only in the neighbourhood of streams, where it often constitutes 90 per cent. of the tree vegetation. The timber is well known on the Lebombo Mountains, on the western boundary of Mozambique, where the tree occurs in dense, pure thickets. The trunk may reach a circumference of 6 ft. and is frequently unbranched up to a height of 40 ft., but very large specimens are said to be usually hollow.

A log of this timber, about 7 ft. long and 2 ft. in diameter, and comprising the whole width of the trunk, was received from the Director of Agriculture at Beira in October 1911.

A noteworthy feature of the specimen was the small proportion of sap-wood present, the log consisting almost entirely of heart-wood, with about 1 in. of sap-wood on the outside.

The wood was yellowish light brown, varied by shade similar to that of satinwood and some of the sandalwoods, and in general character it resembled the latter. It was hard, close-grained, and filled with a reddish-brown resin; it burnt freely, and left very little residue. The wood had a bitter taste, and this may account for its immunity from the attacks of white ants.

The timber split easily but irregularly; it was difficult to saw and plane, but turned and polished well. Logs picked and cut for figure would make good veneers, and could be used for small fancy articles such as are made from olive wood. The wood weighed 60 lb. per cubic foot.

The British wood which this timber most closely resembles is box. The M'Zimbiti wood might be used for turning like box, for although it lacks the clearness of colour of the latter it is less brittle, and shows a figure, which box does not.

The wood was submitted to timber merchants, who obtained the following reports from two firms of commercial experts interested in this class of timber:

(1) The first firm considered that the timber would scarcely be a suitable substitute for boxwood, though, as it seemed to be very hard and close-grained they were of opinion that it might be of use in other ways, if the logs were sufficiently large and clean.

(2) The second firm reported that the wood could be used for various kinds of turnery, if it could be imported cheaply enough to compete with other woods of similar texture. They added that they were prepared to consider its utilisation if the price of the wood and the size of the logs were satisfactory.

TIMBER OF *TRIPLOCHITON JOHNSONII*

T. Johnsonii, C. H. Wright, is a lofty tree belonging to the Sterculiaceæ. It occurs throughout the evergreen and deciduous forests of the Gold Coast and Southern

Nigeria, and reproduces itself freely by seed, young plants springing up abundantly on recently abandoned farm lands. According to H. N. Thompson, *Report on Forests, Gold Coast, Colonial Reports, Miscellaneous Series*, No. 66 [Cd. 4993], 1910, the West African forests contain sufficient supplies of this timber to meet large demands in the home markets and in West Africa.

A sample of the timber from Southern Nigeria was received recently at the Imperial Institute and was submitted to a technical expert, who reported on it as follows:

The specimen submitted was sound throughout, and free from knots and sap. Little or no warping took place in samples which were cut and left for six weeks to test this point. The wood is of a light yellow-brown colour and of little decorative value, but it stains very well. It is light in weight (29 lb. per cubic foot), but is strong and fairly elastic.

Superficially this wood somewhat resembles a light-coloured mahogany, and for the imitation of mahogany it would be superior to American whitewood, being much firmer and stronger, and showing the mahogany-like pore marks which whitewood lacks.

The timber works easily with both machine and hand tools, which is an advantage, as many new timbers are costly in working. It is well adapted for glueing, and is soft enough to take nails well.

The wood is suitable for general joinery work and as a backing for veneers of more decorative materials. It also polishes well. It ignites readily, and is almost completely consumed on burning.

CRUDE PETROLEUM FROM MOROCCO

THREE samples of petroleum were received through the Colonial Office from the British Consul at Fez in July 1910. The samples were as follows:

No. 1.—" Mineral oil discovered in or near Ulad Aissa." This consisted of crude black petroleum containing 1·3 per cent. of water.

No. 2.—" Mineral oil discovered in or near Sherarda."

This was a mixture of water and crude black petroleum, the percentage of the former being 67·1.

No. 3.—"Mineral oil discovered in Sherarda Province at Ain Feriba." This sample also consisted of a mixture of crude black petroleum and water, the percentage of water in this case being 35·5.

All the samples contained some organic matter in suspension.

The oils were separated from the associated water, and were then examined with the following results:

	No. 1.	No. 2.	No. 3.
Specific gravity	0·853	0·874	0·876
Flash-point	78° C.	114° C.	120° C.

The results of distillation were as follows:

Fraction.	Boiling-point.	Yield by volume.		
		No. 1.	No. 2.	No. 3.
		Per cent.	*Per cent.*	*Per cent.*
Light petroleum .	Below 150° C. . .	7	nil	nil
Kerosene . .	150° C. to 300° C. .	70	47	43
Lubricating oil .	Above 300° C. . .	23[1]	40[2]	53[1]
Residue and loss .	—	nil	13	4

[1] *Under* 15 *mm. pressure.*

[2] *Under* 60 *mm. pressure.*

The kerosene obtained from sample 3 had a specific gravity of 0·836 and a flash-point of 98° C. (by the Abel-Pensky closed test). The kerosene fractions from samples 1 and 2 were too small to allow of similar determinations being made.

The above figures show that sample 1, as received, contained only a small amount of "light petroleum" and a moderately high percentage of "kerosene" or burning oil; whilst sample 2 contained no "light petroleum," but yielded nearly 50 per cent. of kerosene. Sample 3 was very similar to sample 2, except that the proportion of burning oil was somewhat lower.

A further sample of petroleum was received in February 1911, from the British Consul at Fez, through the Foreign Office. It was stated to have been obtained near Mazaria in Hejowa, about 30 miles north-east of Fez and within a few miles of the Jebel-Tselfats in Sherarda.

The sample, as received, consisted of rather heavy, dark brown, crude petroleum, mixed with half its volume of water.

The crude oil, after removal of the water, was examined with the following results:

Specific gravity	0·950
Flash-point	105° C.
Bromine absorption, *per cent.*	7·9
Sulphur " "	1·70

The oil did not solidify at 0° C.

A portion of the sample was distilled in order to separate it into kerosene, etc. On heating, the oil evolved sulphuretted hydrogen, together with some unstable sulphur compounds, which deposited sulphur. The results of the distillation were as follows:

Fraction.	Boiling-point.	Yield by volume.	Specific gravity.	Flash-point.	Bromine absorption.
		Per cent.			*Per cent.*
Light petroleum	100–150° C.	1·0	—	58° C.	4·2
Kerosene	150–300° C.	30·0	0·911	81° C.	7·8
Lubricating oil	Above 300° C. at 100 mm. pressure	30·0	0·942	—	7·0
Residue	—	39·0	—	—	—

The "residue" was a thick, bitumen-like mass, which was too soft for use as the basis of an asphalt paving material.

The above results show that the crude oil under examination would be suitable for use as a liquid fuel, or could be distilled to yield a moderate quantity of "burning oil." It was, however, considerably inferior to the previous samples from Morocco, which yielded more kerosene and less bituminous residue than the present sample.

PETROL FROM TASMANIA

EXTENSIVE deposits of oil-shale exist south of Latrobe, in the Mersey district of Tasmania. The shale occurs as a seam 7 ft. thick, and extends over an area of 2,000 acres (see this BULLETIN, 1912, **10**, 685). A sample of petrol distilled from this shale was received for examination at the Imperial Institute in September 1911.

The sample consisted of a pale yellowish oil having the characteristic odour of shale oil. It was examined with the following results:

Specific gravity	0·760
Flash-point	below 15·5° C.
Bromine absorption, *per cent.*	113

The sample was submitted to fractional distillation, with the results given in the following table:

Boiling-point.	Yield by volume.	Specific gravity.	Flash-point.	Bromine absorption.
	Per cent.			*Per cent.*
75° C. to 80° C.	0·3	—	Below 15·5° C.	—
80° C. to 100° C.	20·7	0·740	,,	115
100° C. to 120° C.	47·0	0·758	,,	112
120° C. to 150° C.	28·0	0·774	,,	109
Above 150° C.	4·0	—	38° C.	—

The foregoing results are characteristic of the "naphtha" obtained by the distillation of shale.

It was not found possible to remove the somewhat strong odour of the sample by the methods usually employed for kerosene, without destroying the valuable low-boiling fractions.

This petrol would be quite suitable for use as a solvent, and for various other purposes to which petrol is applied. As regards its employment for internal combustion engines, it would probably be necessary to fractionate the oil, and use only the portion boiling below 120° C. for the purpose.

The following table gives the average results of the distillation of various well-known "motor spirits" obtained from petroleum (see *Proc. Incorp. Inst. Automob. Engin.*, 1908–9, **3**, 301).

No.	Boiling-point of fractions.					Original oil.	
	Below 100° C.	100° C. to 120° C.	120° C. to 133° C.	Above 133° C.	Loss.	Specific gravity.	Began to distil at
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*		
1	65·0	24·8	6·0	3·0	1·2	0·713	58° C. to 65° C.
2	66·6	23·9	5·0	3·1	1·4	0·717	60° C. to 65° C.
3	66·5	23·7	5·8	2·8	1·2	0·717	63° C. to 65° C.
4	39·0	49·0	7·5	3·5	1·5	0·739	70° C.
5	86·5	11·5	—	0·5	1·5	0·700	56° C.
6	73·0	17·5	5·0	3·0	1·5	0·705	55° C.

On comparing these figures with the results of the examination of the petrol from Tasmania it will be seen that the latter contained a larger percentage of high-boiling oil. The fraction boiling above 120° C. amounted to 32 per cent. in the Tasmanian petrol, whereas the maximum in the commercial samples is only 11 per cent.

CRUDE PETROLEUM FROM NOVA SCOTIA

A SAMPLE of crude petroleum from Nova Scotia was received for examination in February 1911. It consisted of a heavy black oil, floating on water.

A portion of the oil was submitted to fractional distillation, with the following results:

Fraction.	Boiling-point.	Yield by volume.
		Per cent.
Largely water	Below 110° C. . .	4
Kerosene	110° to 300° C. . .	56
Lubricating oil	Above 300° C. (under 30 mm. pressure) .	12
Residue (bituminous matter) . .	—	28

The "bromine absorption" of the crude oil was found to be 8·2 per cent. The fraction boiling at 110° C. to 300° C. had the characteristic appearance and odour of the burning oil distilled from a crude petroleum containing a quantity of bituminous matter. It had a "bromine absorption" of 11·7 per cent., showing that a little "cracking" had taken place during the distillation.

The results of the investigation showed that this oil from Nova Scotia was a crude petroleum, containing a fair percentage of bituminous matter, and if the material is obtainable in quantity it would be of value as a source of petroleum.

SPECIAL ARTICLES

THE PROGRESS OF EGYPTIAN AGRICULTURE, WITH SPECIAL REFERENCE TO COTTON

By Gerald C. Dudgeon, F.E.S.

Director-General of the Department of Agriculture in Egypt, Vice-President of the International Association for Tropical Agriculture

Owing to the exceptionally well-organised administration which existed in ancient Egypt, and the zeal which its rulers displayed in recording their actions on stone monuments or by means of well constructed models, which the climatic peculiarities of the country have served to preserve rather than destroy, it is possible to picture clearly the rural life of the distant centuries, and to realise to what a small extent Egyptian agricultural methods have undergone change.

The Nile Valley from the most remote historical times has been renowned for its fertility, which is of a practically inexhaustible nature, due to the fact that whatever is taken from the soil by the crops of one year is replenished by the rich deposit left by the annual flood of the river wherever its waters are permitted to inundate the land. In addition to the enormous advantages which the inhabitants possessed from this perennial soil renovation, there is little doubt that, had they not been safeguarded to a great extent against foreign invasion by their extensive waterless surroundings, they would not have remained for long periods unhindered in the pursuit of their peaceful occupation of tilling the soil, nor have attained the relatively high degree of civilisation in early times which they did.

For centuries the cultivators of the valley grew the same crops, used the same implements for tilling the soil, and employed the same methods of irrigation as are in vogue in parts of the country at the present time, supplementing the watering obtained by the annual flooding of the basins by lifting water from the Nile during low-water periods by means of hand-worked "shadufs,"[1] or cattle-driven "sakias."[2] It was, however, only upon small areas that these latter machines could be used, proximity to the Nile, or to one of the few artificial waterways which had been excavated, being essential; and, considered generally, the whole cultivation of the valley was dependent on the one inundation which the land received from the Nile flood. As the country is, for all practical purposes, rainless, it was only possible to obtain one crop each year from the flooded land. These conditions still obtain in all the districts to the south of Asyut, where canalisation has not been effected.

The whole of Upper Egypt was, until quite recently, under the basin system, but the Delta has for some time had the advantage of watering a large part of the cultivated area from broad canals mostly constructed in the nineteenth century. These canals were, however, for a long time unreliable, and gave constant trouble, yielding no regulated supply of water during times of the greatest need, and being dependent for their flow, previous to the perfection of the Delta Barrage, on temporary dams made in the Nile itself. Wherever flood or basin cultivation is still carried on, without supplementary water from "sakias" and "shadufs," the crops and the means of growing them are probably identical with those in use thirty centuries previously.

The basins are depressions in the alluvial banks of the Nile, which are lower than the river at flood period. They vary greatly in extent, and are supplied with water by means of leads from the river, which flow until the water-level in the basin is level with the river itself. The entrance channel is then closed, and the water in the basins, which attains a depth of one or two metres, is permitted to percolate, or run off after about forty days, so that the large amount of fertilising material, which is held in suspension in the flood water, may be deposited on the soil at the bottom of the basin. In cases where the flood supply is insufficient to cover all the basins with water direct from the Nile, arrangements have recently been made by which the whole of the water from one basin is not permitted to drain back into the river, but a part of it is discharged after some time into the neighbouring basins which may more urgently require it. In this way all the basins are now in receipt of water, and, although in the worst cases there is not much fertilising matter contained in that given to them, it is conceded that the impoverished water is better than none at all.

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[1] A beam working on a pivot, with a bucket attached to a rope suspended from one end and a weight at the other. It is worked by pulling down the rope until the bucket is filled with water from a low level, and permitting the weight to assist in lifting the filled bucket to a higher level, where the water is discharged.

[2] A vertical wheel with an endless chain of vessels running over the circumference, which are raised when filled with water by means of a bullock driving a horizontal wheel geared to the vertical one.

Basin cultivation commences as soon as the flood water has drained away and left the mud capable of bearing the weight of the sower. It is a common method to broadcast the various seeds of the "shitwe" (winter) crops on the still wet surface, covering them by means of the "ramroun," which is a rude type of harrow, chiefly made from palm-tree leaves. This system is termed "lok." More rarely the seeds are dibbled in holes, put in after a light ploughing, or covered by ploughing after broadcasting. This method is termed "hirati," and the resultant crops are usually superior to those where less disturbance of the soil occurs. The more important crops grown in the basins are wheat, lentils, beans, "gilban" (*Lathyrus sativus*), and fœnugrec (*Trigonella Fœnum-græcum*). The two latter are frequently used as a mixed crop, or are sown with wheat and beans. In the case of all these crops the roots penetrate the saturated soil at about the same rate as that at which the water recedes, enabling a harvest to be gathered in the spring or early summer without the application of further watering.

After the seed has been sown no attention is given to the land until the crop is ready for harvesting. The production of wheat is usually fair, and broadcasting has not yet been superseded by planting in lines or drills, whereby a cultivation of the land might be possible, and an even better crop be obtained. No weeding or hoeing can be done in the case of the broadcasted crops, and it is not, apparently, a general practice to do more than break up the surface, when it becomes dry, in the case of beans. Ploughing just previous to sowing is regularly employed in those lands which are capable of being watered by "sakia" or "shaduf"; but in the past, as at present, such positions were used more especially for the cultivation of the sorghum millet, which is by far the most important summer crop, and requires light cultivation, manuring, and regular watering throughout its period of growth.

Such are the simple processes employed by the cultivators in the non-canalised areas, and thus, with a minimum amount of toil, have they gathered harvests annually in the same situations for many centuries, failing only in certain less favoured localities and upon rare occasions when the Nile flood was insufficient in volume to saturate all the land, or when it was too high and strong for the basin banks to withstand the force of the stream.

The methods of cultivation described above sufficed for the requirements of so many generations that the importance of improvements was lost sight of. Meanwhile, under more arduous conditions, agricultural methods became more and more perfected in European countries, far outdistancing those of Egypt.

Labour-saving apparatus was introduced in place of uneconomical methods, and agricultural knowledge in Europe increased while that in Egypt stood still. It is not difficult to realise that the agricultural procedure in Egypt, by long use, has become a part of the people themselves, so much so that, even with the altered conditions induced by improved irrigation and the introduction of new crops, the necessity of modification in accordance with modern requirements is rarely recognised. It had become impressed upon the minds of the cultivators, for instance, that the favourable conditions which had so long prevailed in Egypt were mainly dependent upon the beneficent Nile water, and the aim, therefore, of each successive generation of farmers was doubtless to get as much as possible of this commodity on to the land, to enable them to obtain more from it than the one annual crop which they could procure from the flood watering. The possibility of applying too much water was a contingency hardly considered. Any abnormal condition induced by excessive watering, or even by the occurrence of an insect pest, was not attributed to natural causes, but was regarded as of supernatural origin, and therefore unable to be successfully contended against by human power. The same ideas prevail with a large number of farmers in Egypt at the present day, and have until quite recently constituted a formidable obstacle to progress.

Thanks to the extraordinary enterprise exhibited by one of Egypt's rulers (Mahomet Ali) about the beginning of the nineteenth century, in introducing, among other things, the cultivation of cotton and sugar-cane, and the wise administration of the British Agent-General towards the end of the same century, the country has prospered beyond all anticipation. Had it not been for the introduction of these new products, Egypt might have become at the present time of minor importance, and remained productive of little more, from its rich soil, than would support the needs of its own population. The success which has attended the extensive cultivation of cotton, which was only made possible by carrying out an enormous irrigation scheme, has altered the whole status of the people, and has made Egyptian arable land as valuable as any in the world.

On the introduction of the sugar-cane and cotton it soon became evident that no great areas could be planted without improved facilities for watering: neither crop could be successfully grown in the basins under the usual flood conditions, although cotton has been produced in a basin where dykes were erected and the flood water has only been permitted to enter in sufficient quantity to water the crop. In order to extend the cultivation of these two crops, it was apparent that many more canals were needed, and in addition that their flow should be properly regulated.

The employment of European engineers in the country in the early part of the nineteenth century marked the commencement of an organised irrigation scheme. This has been gradually improved until an adequate and reliable supply of water from the Nile has now become assured to the greater part of Egypt. Not only has the originally canalised area benefited, but it has been enormously extended, and even the basin areas, where canals do not exist, have obtained advantages with regard to regular supplies at flood time. In order to effect this revolution in the water supply of the country, a large expenditure in energy and money was necessary in the planning and erection of regulating barrages, reinforcement of river banks, and the construction of main and branch canals throughout the new areas. Where basins have not yet been converted to canalised tracts, the improvements mentioned before have been made, so that those less favourably situated need not suffer as previously in a bad flood year.

One of the first steps towards the great scheme was the erection of the Delta Barrage at the bifurcation of the Rosetta and Damietta branches of the Nile, by means of which a head of water could be held up and discharged as required into the large canals traversing the Delta and originating from the Barrage. This Barrage, which was commenced in 1843 by French engineers and took twenty years to build, was unfortunately at first unsuccessful and, after remaining ineffective for some years, was eventually repaired under the direction of Sir Colin Scott Moncrieff and Anglo-Indian engineers between 1886 and 1890, with the result that it has been working efficiently ever since. Previous to the construction of the barrage it had been necessary to depend on the "sudds" or temporary barrages which were built annually across the two branches of the Nile, and which held up a limited quantity of water during the low Nile period. These "sudds" were washed away each year by the flood. Although the "sudds" are still constructed near the original places, there is now so little water allowed to flow in the Nile branches during low Nile, practically the whole being diverted into the canals, that what is held up by the "sudds" is chiefly water discharged from the drains or percolated from the cultivated lands.

The network of canals which gradually developed, especially through the Delta, necessitated the employment of a large staff of engineers, having a special acquaintance with irrigation. Salted lands were reclaimed by washing, and the cultivable area of Egypt was increased. Water, which had been regarded by the fellahin as the chief need for cultivation, became plentiful, and was eagerly poured on the soil, especially at flood time, when it carried the valued fertilising matter.

In the case of cotton, a new crop in the country, the excess of watering had a harmful effect, but the fellahin attributed the damage to any cause but that of over-watering. The lessons which had been taught them with regard to the cultivation of cotton, and the special treatment of the soil for its growth, had at first been unwillingly learnt, but the desire for unlimited water supply, which has become a feature in the character of the fellahin, is being still more unwillingly forgotten.

Owing to the uncertainty of the water supply in the early times of the cotton-growing era, only a small proportion of the land could be adapted to it, but as the supply became more assured the area was increased and cotton appeared in the crop rotation, at first once in three years, and, more recently, twice within the same period. Most of the land was unable to renovate itself sufficiently quickly to maintain the crop twice within such a short period, and recourse had to be taken to manures to supply the deficiency of plant food.

Although in many cases the result of the frequency of cotton upon the same land is a diminution in the crop, still the margin of profit is so much higher than that obtained from any other crop that the frequency of its occurrence in the rotation is not likely to be lessened while the price remains high. As the recuperative power of the Nile deposit is apparently incapable of keeping pace with the exhaustion which now occurs in most of the Egyptian soils under the system at present employed, it may be found necessary shortly to make complete analyses of the different soils in Egypt with a view to supplying to each a chemical manure containing the requisite constituents in their proper proportion. Chemical manures are at present used in Egypt with little regard to this.

When cotton seed was expensive and watering had to be more carefully carried out in order to ensure the full benefit being obtained, the seeds were put in at wide distances from one other, and as a consequence each resulting plant received a sufficiency of light and air for itself without encroaching on the domain of its neighbour. With increased facilities of seed supply and irrigation, the necessity for sowing seeds at such wide intervals and for specially preparing and preserving the water channels between the plants has been lost sight of, and it is customary at the present time to plant too closely and with little care of the interspaces. The result is the starvation of the roots of many plants, the lack of light and air, and the general deterioration of the crop. The close leafage forms an admirable protection to the insect pests which attack cotton in Egypt, and the increase of the severity of the periodical visitation of these during the last decade is a marked feature.

The area under cotton cultivation in the canalised districts of Egypt at the present time is about 40 per cent. of the total cultivated area in the same locality. Serious problems dependent upon this disproportionate cultivation are constantly arising. The diminution of the cultivation of food crops is the least important of these, as the profit yielded by a cotton crop more than suffices to pay for the importation of supplies to make up the deficiency. The effect on the soil itself is, as mentioned above, of great importance, and the deterioration of the quality of the cotton, dependent largely on too frequent and too close cultivation, is a prominent matter for consideration.

The quality of Egyptian cotton is the one feature in which it excels and upon which the industry has been enabled to attain such importance. There are, however, several kinds of Egyptian cotton, all possessing some degree of fineness, strength, and length of fibre, but differing in colour, silkiness, and other characters. These different kinds are frequently grown in adjoining fields, ginned in the same ginneries, and placed in so many positions, enabling their seeds to become crossed or mixed, that deterioration of the crop results. To maintain the position of the Egyptian varieties in the markets of the world it becomes, then, a matter of the first consideration to keep them pure according to each type. From the fact that the people themselves are too slow to realise the supreme importance of this, it has become necessary for the Government to take steps to ensure that the purest and best seed of each kind shall be selected and supplied on the most favourable terms to cultivators. This work has been commenced by the Department of Agriculture, and the success with which it has been attended promises much for the future. The operations commenced, with the formation of the Department, in the distribution of the best seed procurable from the ginneries on credit to the small cultivators, and has now been extended to the distribution of specially selected seed grown on the State Domains Lands. This is sold to the larger and more careful cultivators under a contract by which the Government officers are permitted to inspect the fields where the crops are grown, and the cultivator agrees to furnish the name of the merchant to whom the cotton is to be sold, to enable the second generation of seed being followed up by the Department and kept pure for re-distribution.

Pure approved strains of cotton plants are meanwhile being grown on the experiment farms of the Department, and it is proposed that these shall be furnished, when a sufficiency is to hand, to the State Domains. In this way pure-bred varieties will be constantly produced, propagated with special care, and then distributed throughout the country.

Next in importance to the preservation of the unique quality of Egyptian cotton, the maintenance of the yield must be considered.

It is impossible to ensure the productiveness of any crop in any country, generally owing to variation in climatic conditions. In Egypt, however, the climatic conditions are fairly regular, and have less direct influence upon crops than in most other countries where rainfall plays such an important part. In an indirect manner slight climatic changes bring about great variations in the productiveness of crops, especially cotton. The insect pests, cotton worm (see this BULLETIN, 1912, **10**, 584), and cotton boll worm, which are directly responsible for the loss of sometimes more than a million kantars of cotton in one year, are favourably influenced by dull, cool days. The eggs of the cotton-worm moth produce worms which survive readily if such climatic conditions prevail at their hatching, but which die in large numbers if hot and dry weather occurs at the same period. Thus a few days of weather favourable to this pest may make a vast difference in the cotton crop yield.

As mentioned above, the fellah has been accustomed to view a visitation of these pests apathetically, and is usually content to look upon the same as an incontestable action of "Allah," to whom he uncomplainingly leaves the responsibility of their removal even while he sees the whole of his crop being ruined.

The Government is compelled to legislate in order to save the cultivator's crop for his own benefit, and to expend a large sum of money each year to combat the attack.

A Commission has recently been formed to study the subject thoroughly, with a view to preventing the devastation in the future. The fact that stands out prominently with regard to both the cotton worm and cotton boll worm in Egypt is that there are coincident with them none of the parasites which are found to control them in other countries where they occur. The cotton worm, for instance, is a common insect in India, but in that country has never been observed as a cotton pest. It is infested there by certain internal parasites, which appear to multiply in accordance with the numbers of their hosts, and thus a natural balance is produced. The introduction of such parasites into Egypt might have a similar result. Meanwhile artificial means should not be disregarded, and until some less expensive and more effective method can be found, the practice of picking the egg-masses which is adopted by the Government should not be relaxed. In many other countries picking egg-masses is found to be the most expedient manner of combating certain insect pests.

The drainage problem is one which is constantly referred to with regard to Egyptian agriculture, and is occupying much attention at present. The want of efficient drainage is more severely felt by such a crop as cotton than by other more shallow-rooted crops. No irrigation system in Egypt should have been adopted without an equal amount of attention being given to the removal of the water from the soil. In a large part of Egypt there is no natural drainage, such as is usually found in other countries where extensive irrigation works have been carried out.

What usually occurs upon land with inefficient drainage is that the cotton plants develop deep roots when the water table is low, and when this latter rises with the Nile flood these roots become asphyxiated, resulting in the fall of the flowers and bolls. The ideal condition of the plant would be a permanent water table, and, within certain limits, it is not necessary that this should be very deep. The plant will make its roots in accordance with the height of the water in the soil, and the tap-root will not develop to two metres in length if the water is present in the soil at one metre.

The chief obstacle with regard to drainage in Egypt is the low elevation of so much of the land, and the necessity of lifting the water from drains to higher levels, in order that it may flow by gravitation into the sea. Any drainage system would require the co-operation of every one within the area to be drained, or the undertaking of the lift by Government.

Owing to the low elevation of much of the land, the canals which supply water are mainly at a higher level, and are what are called "free flow," as distinguished from those which are at a lower level, from which the water has to be lifted.

The economy of free-flow canals with regard to most agricultural land is at once apparent, but in Egypt they have become a constant danger, from the fact that, when the cultivator is obliged to lift the water for his fields, he is unlikely to apply more than is necessary, whereas, where the water will flow without personal exertion, he is liable to take far too much. This is actually what occurs in practice.

The cultivation of sugar-cane has not met with the same measure of success as cotton: the reasons being mainly that the profits from it are smaller and the land is occupied by it for a longer period, to the exclusion of other crops. As fast as the basin areas have been converted into canalised tracts, sugar-cane has given way to cotton, as the water from the Government canals is supplied free to the cultivators, whereas the water which was previously supplied by pumps on the Nile banks was controlled by the Sugar Company, and delivered at specially low rates to those people who grew sugar and sold the cane to the Company.

Sugar is well suited for cultivation and produces good crops in Egypt, besides being comparatively free from disease. The first improved cane was introduced from Jamaica, and constitutes what is now called the "Beladi," or country cane, having taken the name of an inferior kind which was grown previously on a small scale. During recent years one of the Java varieties, "No. 105," has been grown with success, and experiments have been made more recently with Mauritius cane. As far as has been at present observed no seed is formed on the Egyptian-grown canes, and the different varieties are therefore easily kept pure. In the Delta, sugar-cane is only grown for sale for chewing, and, as such, is a very remunerative crop when planted in the vicinity of large towns.

This brief description will convey some idea of the slow and difficult process by which Egyptian agriculture of the present day is being evolved, and by which the established methods of centuries are being moulded to conform with the requirements of altered conditions and new crops.

The means employed by the Egyptian rulers at the commencement of the last century to instruct the people was the use of the "Kurbash," and at the cessation of its use only a part of the lesson had been learnt. The remainder is being taught by a slower but equally effective method: that of combating mistrust by peaceful persuasion and the appeal to simple reasoning.

THE AGRICULTURE OF MOZAMBIQUE PROVINCE, PORTUGUESE EAST AFRICA

By R. N. Lyne, F.L.S.

Director of Agriculture, Ceylon; lately Director of Agriculture in the Province of Mozambique

The Province of Mozambique, to give the Portuguese territory in East Africa its correct name, extends through 16 degrees of latitude, and as about 4½ degrees of this lies beyond the Tropic of Capricorn, a very considerable part of its area must be classed as sub-tropical, suitable for the grazing of cattle and the cultivation of such crops as maize. This is the case with the administrative district of Lourenço Marques, now including Gazaland, which runs back to the Lebombo Mountains, on the Transvaal frontier. A large proportion of this is semi-forested, low veld that would pasture eight or nine head of cattle per 100 acres. In round numbers it may be stated that this territory could graze a million head of cattle, and that at present five per cent. only of that number is carried. Its great advantage over the high veld is that the native pasture does not fail in the cool season. One or two herds of Shorthorn and Friesland cattle have been established, and experience so far goes to show that heavy breeds thrive and cross well with the native cattle; Devons and Herefords might also be given a trial. Another important fact is that the whole of this district south of the Limpopo river has been cleared of East Coast fever, an achievement for which no little credit is due to the Mozambique Government and to Mr. Conacher, a veterinary officer of the Department of Agriculture, Union of South Africa, whose services were lent for that purpose. The grazing prospects of this sub-tropical part of Portuguese East Africa are thus seen to be very favourable, and there is no doubt that in time a great industry will be built up that will help to supply the markets of Europe with frozen meat.

The Sugar Planting Industry

Foremost among the growing industries of the country is that of sugar-cane planting, for which the magnificent river systems offer great facilities. The output of sugar in

1910 was over 30,000 tons, but it is safe to say that in 1914 this figure will be nearly doubled. The valleys of the rivers Inkomati, Buzi (in the Mozambique Company's territory), and Zambesi, which are proving the most attractive to sugar planters, are low alluvial plains which extend in the case of the Zambesi for a length of 150 miles. The estuaries are brackish to a distance from the sea indicated by the limit to which mangroves reach, usually some thirty miles, following the windings of the rivers (less than this in the case of the Buzi), and the neighbouring land is unsuitable for sugar planting. A margin above this should also be avoided, as the rivers are subject to serious periodic floods, the plains being converted into enormous lakes for a period of a month or more. The Limpopo valley is especially liable to inundations, and as a consequence has been hitherto neglected by sugar planters. Above the limit of serious flooding—in which description is not included submergence for three or four days only, provided there is no devastating torrent—the conditions for sugar planting are ideal, though search should always be made for the black alluvium the heavy, luscious canes require, and sandy outcrops avoided. The land slopes gently back from the banks, a characteristic feature with rivers of this type, and one very favourable for irrigation. The streams, though shallow, are usually navigable for shallow boats, the bars at their mouths being pierced by narrow channels. Water for irrigation is lifted by centrifugal pumps driven by fixed or portable engines.

The difficulties confronting the sugar industry of Natal, arising from the prohibition of imported Indian labour, are proving advantageous to Portuguese East Africa, the new enterprises in the latter country being financed to a considerable extent by Natal and Transvaal capital; but Mozambique has labour difficulties of her own, and the available labour supply is a matter every investigator should carefully examine before investing his capital.

The many kinds of cane cultivated fall into two groups: the one consisting of luscious green and purple canes of local or foreign origin, the other the hard Yuba, a variety discovered some years ago in Natal which is said to have saved the Natal sugar industry by its wonderful powers of ratooning and of resisting drought, characters due to its habit of deep rooting. There are fields of Yuba on the Zambesi from which twelve or more ratoons per plant have been taken. It is probable, however, that on the rich alluvial plains heavy canes will oust Yuba, which is essentially a dry land cane.

Rubber

The Landolphia rubber forests represent the greatest agricultural asset the Province possesses. Including those of the Mozambique and Nyasa Companies' territories, their capital value is not far short of fifteen million pounds sterling. How best to exploit this rubber is the problem now engaging the attention of the Government, though it is agreed it can only be thoroughly done by private capital. Two methods of obtaining the rubber have been suggested: one consists in tapping the vines, the other in cutting them down and putting the stems through extracting machines for the separation of the rubber from the bark. By tapping the vines, it is maintained that they will be preserved throughout an indefinite period and be a continual source of income. No satisfactory method of tapping, however, has yet been discovered, that adopted by the natives, viz. "scarring" the trunk or slicing off pieces of bark, being destructive, as the operation is usually carelessly performed and a piece of the cambium is generally cut away with the bark. The vines are distributed so sparsely and irregularly that systematic tapping could not be properly supervised, and even if it could, it would scarcely pay an employer to have his men spending their time looking for tappable vines; nor, if the men were on piece-work, would it pay them to work systematically through wild forests. Left to themselves to tap where they please, we come back to the present wasteful system of tapper and merchant.

Those who advocate cutting down the trees and extracting the rubber by machinery argue that forests can be renovated by replanting or natural regeneration within a period variously estimated at from six to twenty years, but no Landolphia forest in East Africa has yet been renewed in this way, and hence no results can be quoted in support of this view, which is therefore purely speculative. It seems very probable that the existing rubber vines have grown up with the forest and that only in the partial shade afforded by a young growing forest could the vines have attained their present size. If that is so, the cultivation of Landolphias is not a practical proposition, as no private capitalist would lock up capital for the time required to rear a forest.

After studying the question carefully, the present writer has come to the conclusion that the circumstances of the Landolphia rubber forests do not permit of their being managed as plantations, and that probably the only practical and profitable method of obtaining the rubber is to cut down the vines, extract the rubber by machinery, and utilise the land for new crops.

Ceara rubber is being established in the Quilimane district, where in the hinterland it thrives better than in any other district of the Province (see this BULLETIN, 1911, **9**, 390).

The southern part of the Province, *i.e.* south of the Zambesi, on the whole is too dry for Ceara rubber, the dry season being so long, and the period over which tapping operations can be carried on is, as a consequence, so restricted that there is not sufficient time for getting out a paying quantity of rubber. In Quilimane the annual rainfall is 60 in. or more, fairly well distributed throughout the year; the country is intersected with rivers and brooks, and the soil is fertile. The Ceara rubber plantations that have been formed look fresh and vigorous where they have been properly cared for, the trees yielding latex freely.

Oil-producing Plants

With a tropical coast-line of close upon 1,000 miles in length the Province might be expected to offer rich possibilities for coconut planting; but dry sand-dunes, on which nothing but the scantiest herbage will grow, monopolise the greater part of this belt. There are redeeming strips in Quilimane, and to a less extent at Inhambane, but not even the best of these can be described as first-class coconut land comparable with that of Zanzibar, for example. Nevertheless much enterprise is being shown at Quilimane by the various Prazo companies, who are going in for extensive new cultivation. The drawback there is that the hard and dry coconut soils are cut into by swamps, through which costly drains have to be cut. These drains are not all kept working, and some become choked with weeds, so that stagnant water accumulates round the roots of the palms. As a result the palms become unhealthy, and the plantations abound in mosquitoes.

Trichilia emetica, known locally as "mafureira," the seeds of which are the source of mafura tallow, occurs abundantly at Inhambane (compare this BULLETIN, 1903, **1**, 26; 1908, **6**, 376; 1912, **10**, 315). The Trichilia belt extends for some 250 miles, but this enormous natural wealth remains almost entirely neglected, only about 1,000 tons of seed being exported annually, representing some 2 or 3 per cent. of the total crop. As is the case for many natural forest products, the price offered for the seed is scarcely sufficient to tempt the native villager to collect the seed or the European to organise an export industry in this product. Transport in the country is particularly difficult, there being no railways or metalled roads; and the soil being sandy, the roadways become cut up into sandy tracks too heavy for wheeled traffic. It can scarcely be doubted that the mafureira industry of Inhambane is destined in time to be taken in hand by some enterprising firm.

Mozambique ground nuts are of excellent quality, but it will not repay the employer of labour to cultivate them. The industry is solely in the hands of natives, large quantities being produced in Quilimane for payment of the tax collected in kind by the Prazo companies.

Telfairia pedata, jikungu, or mkweme, as it is called farther up the coast, flourishes in Inhambane; but the kernels, though rich in oil, cannot yet be utilised in industry (see this BULLETIN, 1912, **10**, 223).

Sisal Hemp and other Fibres

This plant grows from one end of the Province to the other, and there is no part of East Africa where the cultivation of Sisal hemp offers such good prospects as in many places in Mozambique. Water—running water, if possible—is an indispensable requirement for a factory extracting Sisal hemp. The factory should be placed on the bank of a river, so that the stream can be tapped higher up and running water led through in such a way that the pulp falls into an open drain and is carried direct to the river. On the assumption that 3 per cent. of fibre is obtained from fresh Sisal leaves, the production of 3 tons of fibre would necessitate the moving of 100 tons of leaves as well as 97 tons of refuse. By arranging that running water removes the pulp the producer is relieved of the expense of handling this 97 tons of waste and the cost of working is considerably reduced. The soaking tank also should have water running through it. In a country so magnificently served with rivers as is Mozambique there should never be any difficulty about obtaining these conditions. Sisal does best in a dry soil and climate, the percentage of fibre, a very important point with such a bulky crop, being likely to be higher with conditions on the dry side, as in those of Portuguese East Africa. Those who contemplate planting Sisal should study carefully the modern type of self-feeding and reversing decorticators.

Sisal grows on the banks of the rivers that flow into Delagoa Bay, but that part of the Province is only just within the Sisal belt. The soil and climate of Inhambane suit it well. On the banks of the Sabi, in the Mozambique Company's territory, a new plantation is being opened, while in the Quilimane District there are three plantations: one on the banks of the Shire, and two belonging to the Boror Company and aggregating 2,500,000 plants, on the river Inhamiara. A sample from one of these, the Malinguini estate, was favourably reported on recently by the Imperial Institute (see this BULLETIN, 1912, **10**, 131).

Furcræa gigantea, Mauritius hemp, can be grown over a greater range of latitude than Sisal. It is cultivated in the Inhambane District, where difficulty has been experienced in obtaining plants of Sisal; and a Furcræa plantation has also been opened near Lourenço Marques. The percentage of fibre in Furcræa is appreciably less than in Sisal (compare this BULLETIN, 1910, **8**, 270), and it is unlikely that Furcræa will prove popular in the Province.

Phormium tenax, New Zealand flax, would probably suit the low, marshy river flats of the southern extremity. It has the advantage over Sisal of being free from spines, and therefore an easier crop to handle. It yields up to 12 per cent. of fibre, and, once established, will continue for years, closing up its ranks and requiring no weeding.

Cotton

Cotton has as yet made no headway in Portuguese East Africa. Some years ago the Oceana Company made extensive trials on the Sabi with Egyptian cotton, but abandoned the enterprise after sustaining considerable loss. Egyptian cotton has not been entirely satisfactory in any of the East Africa Protectorates, and in Mozambique has been a failure. There the dry season is the cool season, and the cotton is planted in "autumn," not in spring, as in Egypt. Long-staple, improved American Upland, which is proving so successful in Nyasaland, is manifestly the type indicated, and trials have already been made with it on the banks of the Shire—without, however, as yet, any conclusive results. The question of climate has not been sufficiently studied, and so it is impossible as yet to say where, if anywhere, cotton can be successfully grown in Portuguese East Africa.

Tobacco

One of the most profitable industries in Nyasaland at the present time is that of tobacco planting, but this product has not yet received the attention it deserves at the hands of the Portuguese Government. There is no reason to suppose that the successes of Nyasaland and Rhodesia could not be repeated in many parts of Mozambique. Inharrime, south of Inhambane, is now the principal tobacco-growing centre, the industry there being principally in the hands of Greeks, who produce what is in fact little better than Kaffir tobacco, that manufacturers in Europe would not look at. The market is the town of Lourenço Marques and the Transvaal.

Air-curing is at present employed, but no great industry, such as that now growing up in Nyasaland, is likely to become established until flue-curing is adopted with American types of tobacco, and for this the services of a tobacco expert should be engaged, and the co-operative system of curing and marketing started among small producers. A beginning could be made at Inharrime, where the soil and climate are well suited for tobacco. The local markets, though they can keep a few small settlers going, could not absorb any great quantity of tobacco, especially of fine grades.

The Zambesia Company is building flue-curing houses on their estate at Bompona on the river Shire, and planting American types of tobacco principally, though trials will also be made with Turkish, Sumatra, and Cuban tobaccos. These are the first flue-houses to be built in the Province, and the Zambesia Company deserves credit for the enterprise they are showing. It is an example that, it is to be hoped, others of the great Prazo companies will follow. Tobacco is also produced in Tete, but this somewhat inaccessible district, three weeks or a month from Chinde when the Zambesi is low and navigation restricted to house-boats, is not yet likely to attract settlers in any numbers.

Quilimane

Quilimane deserves special mention because not only is it the most fertile district in the Province of Mozambique, but also in the whole of East Africa, as far as the writer's experience goes.

The map shows many rivers between Cape Delgado and the Zambesi, but most of these are but dry watercourses except in the rainy season, when they become rushing torrents. Quilimane, however, is traversed by eight or ten considerable rivers, flowing with abundance of water throughout the year, and in addition the country is intersected with innumerable running streams. Quilimane possesses this first essential of successful agriculture, namely, a good river system in an unparalleled degree as far as East Africa is concerned. Behind the coconut belt stretches of rich argillaceous swamp bottoms are met with, destined to be drained and to come under sugar-cane. The country rises gently from the coast, and as soon as the sugar-cane land is left, forest loams are encountered, varying in quality but never poor. On these, rubber, fibres, fruit, cocoa, vanilla, and tobacco would flourish, as already stated. The annual rainfall is about 60 in., and is well distributed; near the Nyasaland border it is probably more, and the climate is not unhealthy as African climates go.

To conclude, Mozambique is the country of the syndicate and the steam plough, and in only two places has close settlement yet been attempted. One of these is Namahasha, on the Lebombo Mountains, near the Transvaal, the other Macequece, on the Beira railway, close to Rhodesia. Two or three farmers are settled on the banks of the Umbeluzi, catering for the Lourenço Marques market in fruit, milk and lucerne; but half-a-dozen farmers could easily supply these local demands. The Transvaal already sends fruit and milk to Lourenço Marques, so it would seem that the Johannesburg market is not likely to afford a profitable outlet for surplus stock from Delagoa Bay. Furthermore, it seems likely that under prevailing conditions, sugar-cane would pay better. Maize growing is in the hands of the natives, and is likely to remain so.

THE POTTERY INDUSTRY OF ILORIN, NORTHERN NIGERIA

By Dr. J. W. Scott Macfie

Medical Officer, Ilorin, Northern Nigeria

Before European traders introduced foreign crockery and enamelled ware into Nigeria the natives had to rely on their potters to supply all the ordinary household utensils; for metal vessels are comparatively rarely met with, being too costly for the common people, and calabashes, although grown in a great variety of shapes and sizes, and even provided with natural necks, are not suitable for all purposes. Native pottery is still, however, generally preferred to European substitutes, which are unfamiliar and expensive, and moreover are often ill-adapted for native use. The water-pots used by the women at the wells, the little

PLATE I.—RED POTTERY.

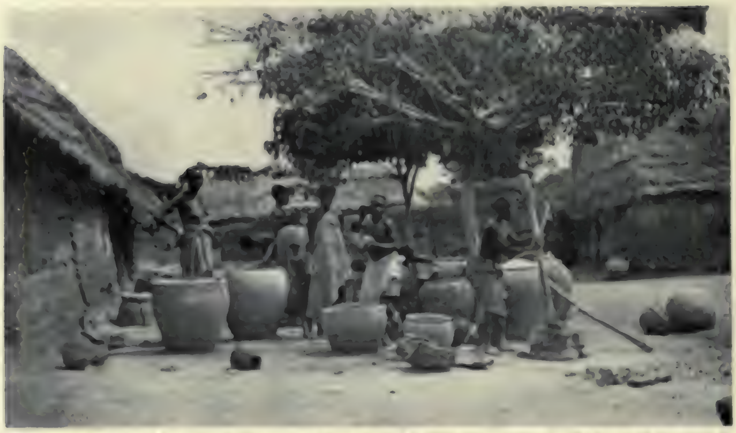


FIG. 1.—A potter's compound. Women making large water-pots, and preparing clay.

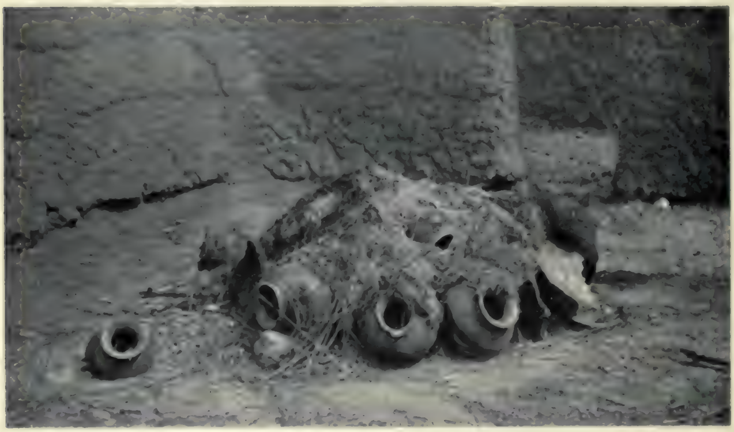


FIG. 2.—Firing the pots.

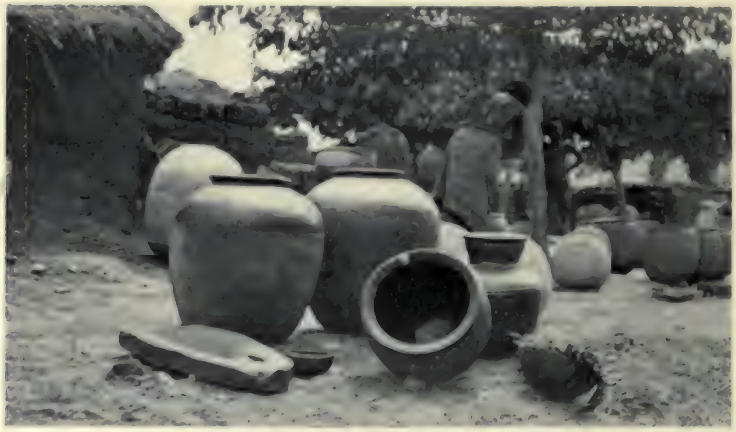
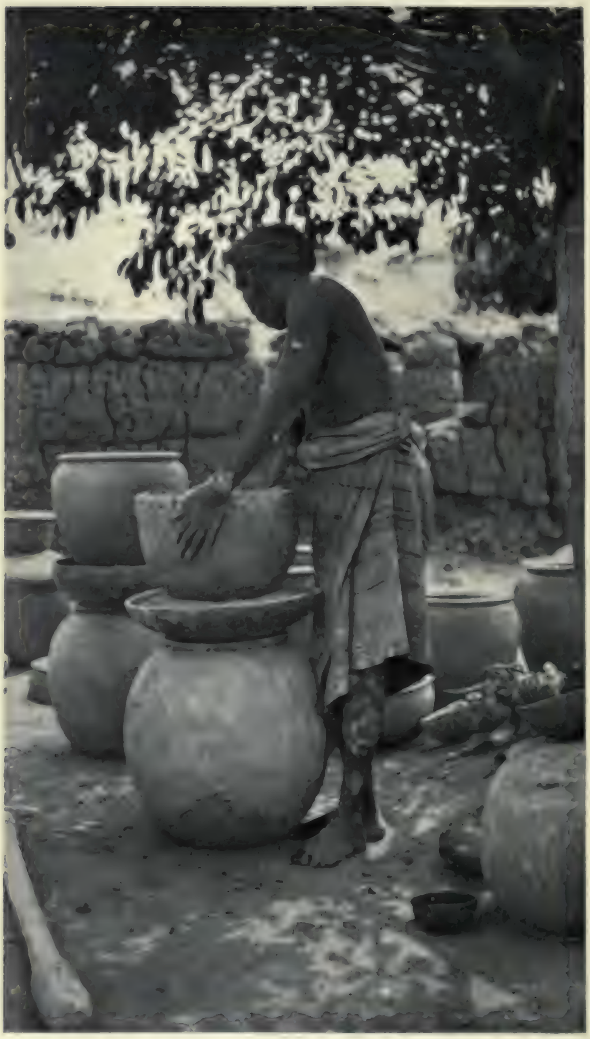


FIG. 3—A corner of a potter's compound.

PLATE II.—RED POTTERY.



Adding the rim to the vessel.

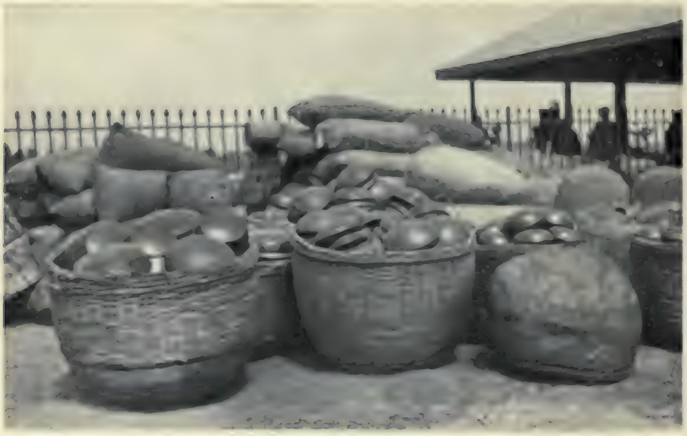


FIG. 1.—Baskets full of pottery waiting to go by railway into Southern Nigeria.

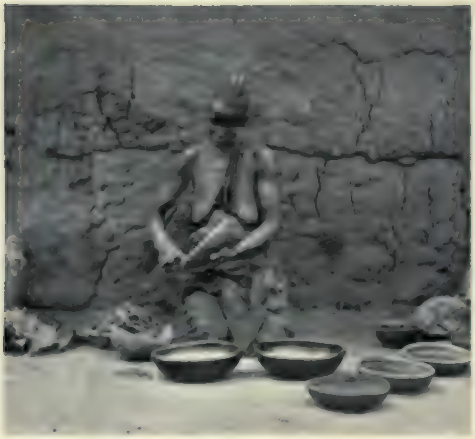


FIG. 2.—Woman finishing a dish.

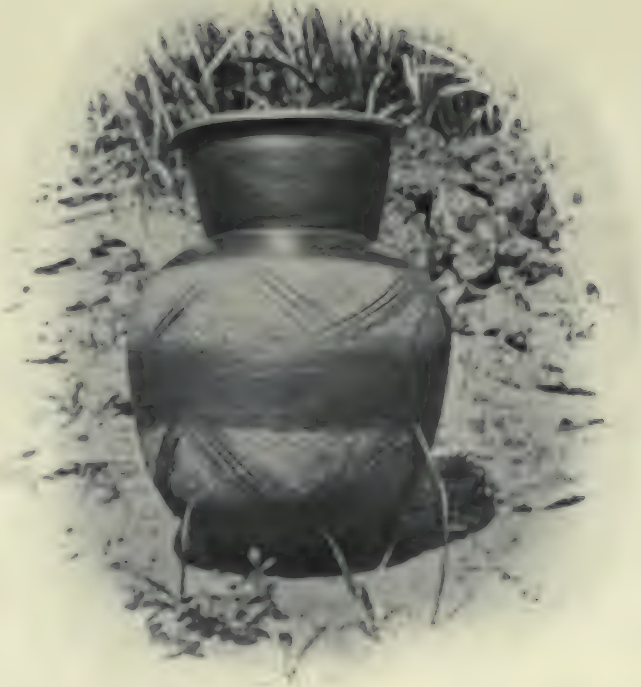


FIG. 1.—RED POTTERY.

A large water-pot, height 17 in., diameter of mouth 7 in.

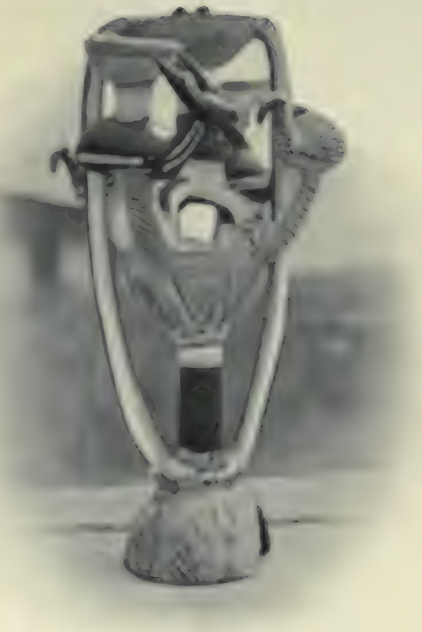


FIG. 2.—PAINTED POTTERY.

Ornamental lamp; a typical example of this ware. Decorated with the figures of two antelopes, two guinea-fowl, and, in the centre, a bird in its nest; painted in blue, black and magenta, on a white ground.

PLATE V.—BLACK POTTERY.

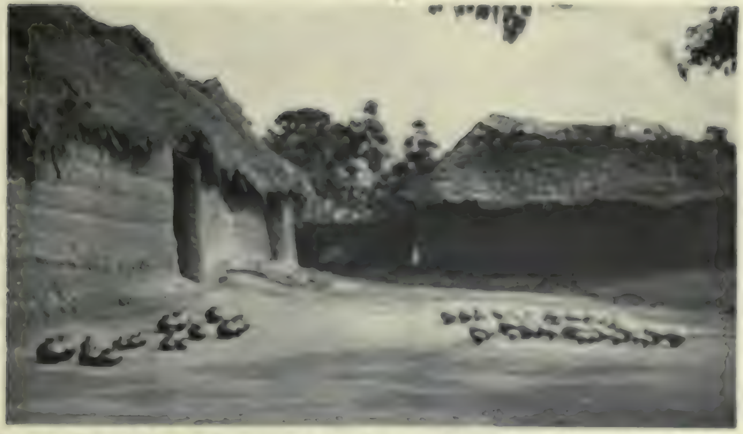


FIG. 1.—Pots laid out for sale, and others, not yet burnt, inverted and drying in the sunshine.

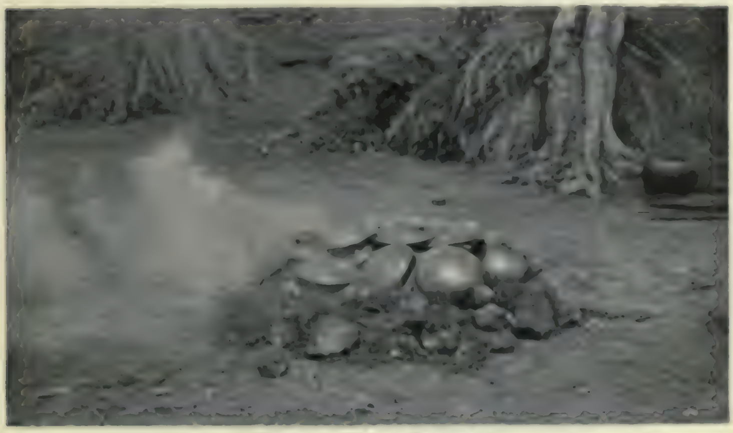


FIG. 2.—Firing the pots.

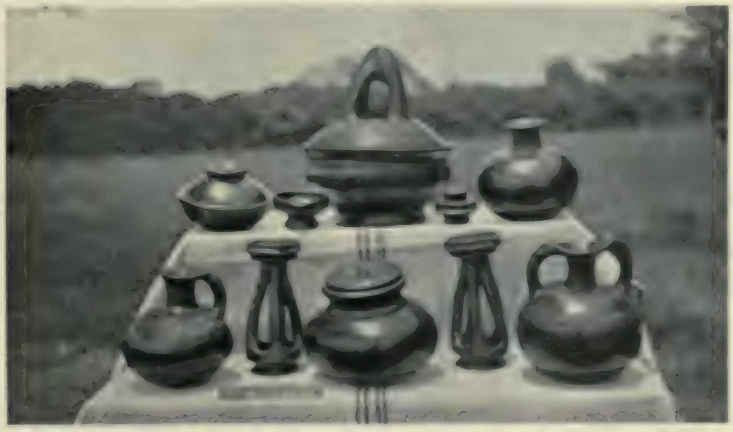


FIG. 3.—Typical examples of the ware.

PLATE VI.—PAINTED POTTERY.

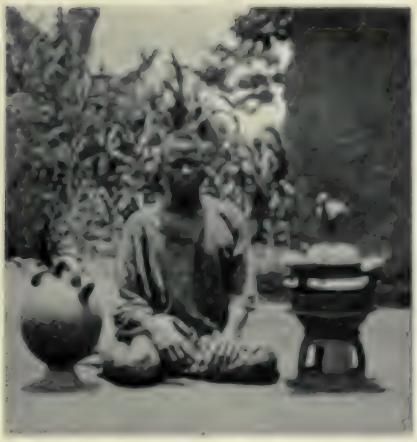


FIG. 1.—The potter and two of his vessels. The latter are being dried in the sunshine before being burnt.

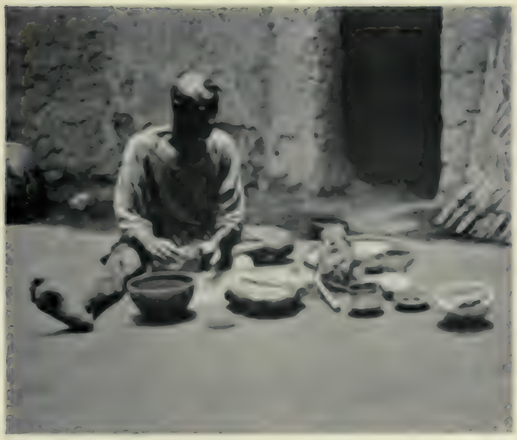


FIG. 2.—The potter at work.

horseshoe-shaped grates for cooking, the moulds for *agidi* (a favourite native food), and all the larger vessels, such as the great pots in which water is stored, and the vessels for brewing *pito* (the native beer) and melting shea butter, are of native manufacture. The great majority of the cooking-pots, dishes, and bowls for food are also of the same wares; and ewers, cruises for oil, lamps, and ink-bottles of native pottery are in common use. A few purely ornamental vessels are also made, such as the painted ware of which illustrations are given (Plate 4, fig. 2; Plate 6, fig. 1). Others, such as the curious pot in the middle of the top row of the examples of black pottery seen in Plate 5, fig. 3, have superstitious significance. Parents who wish to have children place such a pot in one of the little *juju* huts so common in the native towns. Pebbles gathered from the river-bed are placed inside it with a little water, and, a fowl having been sacrificed, its blood is poured over the top of the pot.

Ilorin, the largest city of Northern Nigeria, and the headquarters of the province of the same name, is situated on the Nigerian railway at a point 246 miles from Lagos, and 59 miles from Jebba. The city is 9 miles in circumference, and is estimated to have between 30,000 and 40,000 inhabitants, but this number is augmented during the dry season by a floating population of many thousands. Quick to avail themselves of the means of rapid transport afforded them by the railway, the natives not only travel freely up and down the line themselves, but also make use of it for the distribution of their goods. Amongst other exports great baskets full of the pottery made at Ilorin may be seen almost any day of the week at the railway station waiting to go south to Lagos, and north, at any rate as far as Zaria (Plate 3, fig. 1). It was this sight that led the writer to enquire into the native industry, and to take the photographs reproduced in the present article.

Two main varieties of pottery are made in Ilorin, which for convenience may be designated respectively "red" and "black." Although there are isolated compounds within the walls in which pot-making is practised, the potters, who are invariably Yoruba women, congregate mostly in one district of the town, viz. that to the north-west. The makers of the red pottery and the black both inhabit this quarter, but, although there is a tendency for two or three neighbours to be occupied as manufacturers of the same variety, there is no sharp separation of the two classes.

Only the women make pottery,[1] and only certain families are employed in this industry. The writer was unable to discover any traditions relating to its introduction, or any reason why the work should be restricted to women; enquiry was invariably met by the assertion that the potter had been brought up in the business by her mother, who in turn had learned the trade from her mother. The shapes of the pots are similarly established by long usage, and, for the most part, each potter limits herself to the making of one or two forms. Certain of the types are undoubtedly derived from the calabashes and gourds that abound all over the country, and are used for many purposes instead of vessels of clay. The makers of red pottery are quite ignorant of the processes employed by the makers of black pottery, and *vice versa.*

Red Pottery

The commonest variety of pottery in Ilorin is a red ware, often rough, with but little decoration, and "varnished" only over the upper portions. Several qualities are made; some very coarse, of a mottled red colour, unglazed and unornamented, such as the little bowls used as moulds for *agidi*, a sort of native blancmange; others carefully smoothed, of a fine red colour, and covered with simple ornamentation. Of such ware are the large water-pots, the household utensils, and the horseshoe-shaped grates used for cooking. The initial stages in the making of pottery, whether it be the red or black, seem to be similar, and it will be convenient to describe them here, taking as a concrete example the evolution of a simple hemispherical pot such as that which Senabu, an old Yoruba woman, the head of a family of potters, made in the presence of the writer.

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[1] In northern Africa also the potting industry seems to be largely in the hands of women. In Algeria, for example, Prof. van Gennep observed that Kabyle pottery was the work of women (A. van Gennep, "Études d'Ethnographie Algérienne," tirage à part de la *Revue d'Ethnographie et de Sociologie*: Paris, Ernest Leroux, 1911, p. 13). MacIver, however, notes that "it is only in Nubia that women are the potters; elsewhere in Egypt the master-potter is always a man, and if the women take any part in the work, their share is confined to the burnishing and decorating" (D. Randall MacIver, "The Manufacture of Pottery in Upper Egypt," *Journal of the Anthropological Institute*, 1905). It is not the writer's intention in this paper to deal with the interesting ethnological questions arising out of these observations on the pottery industry of Ilorin, but this opportunity may be taken of referring those interested in the subject to the admirable treatise by Prof. van Gennep mentioned above.

The various appliances referred to may be distinguished in Plate 1, fig. 1, where the potter herself is seen in her own compound superintending assistants who are building up large water-pots. The potters work in the open air under the shade of a tree, and surrounded by a number of large vessels containing the materials—water, earth, and *wia*, of which to make the paste, and prepared paste carefully covered by a damp cloth. Scattered here and there are smaller dishes containing "locust-bean" extract, emulsion of *lentana*, etc. (Plate 1, fig. 3; Plate 2). In another part of the compound, or somewhere close at hand, is the open space in which the pots are burnt, and some of the neighbouring huts are set aside as store rooms, where row after row of the finished ware can be seen.

Squatting on the earth, Senabu prepared a small patch of ground before her, sweeping it clean with a brush of twigs and dusting it over with ashes. On this she dumped a lump of grey-coloured clay, and rising, trampled it with her feet until it was of the requisite size and thickness. With this cake of clay she fashioned the base of a vessel, moulding it over the bottom of an old pot which had been carefully powdered with ashes, and beating it, first with a flat stone, and then with a slipper-shaped piece of wood, until it was spread evenly over the surface. Then, dusting the clay with ashes, she lightly sprinkled it with water, and smoothed its surface with her moistened hands. The pot was then ready to receive the simple decoration customary on such ware. By rolling a short plait of wet cord round the pot with her fingers, Senabu imprinted a band as wide as the full length of the plait (about 3 in.) midway between the bottom of the pot and its ragged edge.

With a twig she smoothed down all excessive roughnesses that occurred in the band, indented two circles at its lower edge by means of her forefinger covered by a damp cloth, and finally, using a small stick, traced a zigzag line over its full width. The base of the pot thus fashioned was gently lifted off the mould and laid aside to dry.

When sufficiently dried the base is laid, concave side upwards, on a surface of sand or earth contained in a shallow calabash, which rests on the top of a large pot, and the rim is added (Plate 2). In doing this the potter stands over the vessel and works gradually round its circumference, moulding on the rim with the fingers of her right hand whilst supporting the outer surface with the palm of her left. In the case of larger vessels such as water-pots, two or three successive zones of clay are added to the base, the clay of each zone being allowed to dry before the next is added, the rim being the last (Plate 1, fig. 1). Nothing in the nature of a potter's wheel is in use at Ilorin.[1] The outer surface of the upper part of the vessel is next carefully smoothed and allowed to dry in the sunshine for a day. Before being burnt the pots, which are then light grey, are smeared with a watery paste to give them their red hue. Pots of a poor quality are smeared with moistened ferruginous earth,[2] which imparts to them a rusty colour, but for the better qualities triturated *lentana* (a red stone brought from French territory west of Sokoto, out of which also beads and other personal ornaments are cut) is used, which produces a richer red. [This *lentana* is a red, earthy ironstone of the type commonly called laterite. It is somewhat porous, but fine in texture, and free from grit or sand.—Ed.]

The pots are fired in heaps (Plate 1, fig. 2) with dry grass, being separated from one another by fragments of pottery, and surrounded by a circle of old pots, an arrangement that may be considered to indicate the dawn of the idea of an oven. After about six hours they are removed, and, before being finally disposed of, are smeared over with an aqueous extract of the pods of the locust tree,[1] a kind of "varnish" which gives them a shiny surface. In the foreground of Plate 1, fig. 3, a piece of *lentana* is seen lying on the stone on which it is rubbed down into a powder, also a bowl of the emulsion of *lentana* with water, a larger pot containing the extract of the pods of the locust tree, and the bundle of leafy twigs with which the liquids are applied to the pots.

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[1] In Southern Nigeria, however, a rude substitute for a wheel is in use. See John Parkinson, "Notes on the Asaba People of the Niger," *Journal of the Anthropological Institute*, 1906; and N. W. Thomas, "Pottery-making of the Edo-speaking Peoples, Southern Nigeria," *Man*, 1910, No. 53.

[2] In Upper Egypt MacIver notes that "the use of the hæmatitic coating is distinctly Nubian" (D. Randall MacIver, *loc. cit.*).

The clay is dug out of shallow holes in the ground, and is intimately mixed with a white, gritty powder called *wia* [this consists essentially of felspar.—Ed.]. In Plate 1, fig. 1, a girl is seen pounding a lump of clay with a large wooden pestle. The clay as used in making the pots is of a dull grey colour.

Red pots are made in a considerable number of shapes and sizes, some of which are seen in the accompanying illustrations. Their dimensions vary from the toy vessels 2 or 3 in. high made for children, to the large water-pots, many of which stand 24 in. or more, and have a diameter across the mouth of 18 in. The commonest form is the simple hemispherical pot with an everted rim, and these are made in a great variety of sizes. As a rule only the upper third of the pot is bright red, smoothed, and "varnished," whilst the lower two-thirds are rough and dull red in colour. Large water-pots are made either with or without necks, and the former, being the more difficult to make, and often simply decorated, naturally command a higher price. Comparatively few of these red pots are ornamented, and the decorations, when employed, are of the simplest, as a rule merely one or two indented lines round the shoulders of the vessel to mark the lower limit of the "varnished" upper areas, or roughened bands rudely scored with zigzag patterns (Plate 4, fig. 1).

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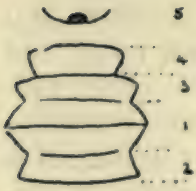
[1] "'Doriwa' or 'dorowa' (*Robinia pseudacacia*), a tree resembling an acacia, called in America the locust tree" (*Dictionary of the Hausa Language*, by Charles Henry Robinson, 1906, vol. i. p. 46). But in the appendix to the same volume, in the "List of Plants with Hausa names and botanical identifications," by Dr. Dalziel, "dorowa" is identified as *Parkia filicoidea* (Leguminosæ).

[The "locust tree" of Northern Nigeria is undoubtedly *Parkia filicoidea*. The pods have been analysed at the Imperial Institute and shown to contain a large amount of mucilaginous matter soluble in water. This would be extracted by water, and the extract, when applied to pots, would be fairly permanent in a dry country such as Northern Nigeria, but would gradually disappear in use in a humid climate.—Ed.]

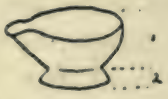
Black Pottery

The makers of black pottery are also Yoruba women, living for the most part in the north-west district of Ilorin, and the art is handed down in certain families from generation to generation. Nor could any history or tradition of the introduction of the industry be obtained. In each compound a single form of vessel is produced, or, at most, two or three forms.

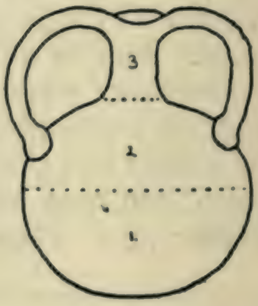
The initial stages in making a black vessel are identical with those described above in dealing with red pottery, and the clay appears to be similar. First the base of the vessel is made and partly sun-dried, then the rim or top is added and the whole again exposed in the sunshine to dry. Plate 3, fig. 2, shows a woman adding the rim to such a base, whilst to her left lie several drying dishes. The more elaborate vessels are made in several stages, as is indicated in the following diagram by means of numerals so placed as to mark the various stages of the building up. The body (1) of the ink-bottle, for instance, is the first piece to be moulded, and to this are added successively the foot (2), the shoulder (3), the neck (4), and finally the lid (5).



Ink-bottle.



Lamp.



Water-bottle

When nearly dry the greyish-white vessels are carefully polished by rubbing with a round and perfectly smooth pebble until a fine surface is produced. They are then exposed in the sunshine once more until they are completely dry. In Plate 5, fig. 1, a group of vessels thus exposed is seen; they may be distinguished from the completed pots laid out for sale by their white colour.

When dry the pots are burnt in heaps (Plate 5, fig. 2). In this case damp grass is employed and the black colour of the vessels is chiefly due to the permeation of the ware by the smoke. Firing takes twelve hours or more, the heaps being ignited in the afternoon and left undisturbed until the next day. Finally the pots are removed while still hot, dipped twice in an aqueous extract of the pods of the locust tree, and set aside to dry. A fine black colour with a brilliant lustre is thus obtained.[1]

A great variety of shapes is made, some of the commoner of which are illustrated in Plate 5, fig. 3. One curious form used to dry meat is not, however, shown; this is a wide-mouthed vessel fitted with a lid pierced by a great number of little holes. Many of the vessels are without decoration, others have simple patterns traced round them—deep bands of zigzag lines, circles and rows of dots, or radiating streaks that scarcely indent the surface, but are conspicuous in certain lights. Such patterns as these are traced after the surface has been smoothed with the pebbles and before the pots are burnt. The black pottery is greatly prized by the natives, as is indicated by the fact that it is carried all over the province heaped up in loads on the heads of women, and that by railway it reaches down to the seaboard at Lagos, nearly 250 miles distant, and northwards at any rate as far as Zaria, some 376 miles beyond Ilorin.

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[1] In the Ridyard collection at the Liverpool Museum there are a number of examples of West African pottery, including specimens, brought from the Gold Coast, of both red and black wares. The vessels are for the most part more highly finished than those collected by the writer in Northern Nigeria, and seem to indicate a more advanced stage of development. The writer is indebted to Mr. P. Entwistle, of the Liverpool Museum, for the following notes by Mr. A. Ridyard on the manufacture of pottery at Oblogo, Gold Coast Colony, from which it will be observed that the processes differ considerably from those in use at Ilorin:

"The pots are made from a local clay. The clay is mixed and allowed to stand in a cool place for two days. The pots are then worked up by hand on a piece of board and smoothed with stones; when made they are allowed to stand in the sun for three days to harden before firing.

"They are then placed in a conical fire made of sticks placed on end with a bed of dry grass. Several pots are fired at once, each being kept separate. They are fired for exactly forty minutes and are then found to have burnt red. If it is desired to finish the pot in this condition it is allowed to cool, and is then coated with a thin paste of a special red clay obtained from the gold district in Ashanti and polished with pebbles.

"Should the pot be required to be finished black, it is taken out of the fire after forty minutes burning and at once placed in a bed of leaves for twenty minutes, being kept constantly moved to allow the blackening process to be effective on all parts; at the end of this time it is found to be completely blackened. The black can be polished with the pebbles as in the red stage. Care is taken to keep the leaves from firing by damping if necessary. The whole of the operations are protected from the wind during firing and smothering, or smoking, the pots being constantly turned by means of a stick."

Painted Pottery

A third variety of pottery is occasionally met with in Ilorin, of which the lamp illustrated by Plate 4, fig. 2, is a typical example. These ornamental vessels, often of elaborate design, decorated with the figures of birds and animals, and painted in gaudy colours, are the work of a single potter, a Hausa man. Although this ware is evidently not native to Ilorin, it may be of interest to include here a short account of the manufacture of these remarkable vessels.

After some little difficulty the writer succeeded in tracing the maker of the painted pottery, and visited him for the purpose of taking the accompanying photographs. His compound was situated on the western fringe of the town, close to the caravan road, and apart from the other potters, the women who make the red and the black wares. There were one or two pots laid out on the ground to dry in the sunshine (Plate 6, fig. 1), and the potter himself was working at a lump of clay in the shade of a little mud hut. He was a Hausa, a native of Goja, but had been living in Ilorin for a number of years. He said he had learned his art from a fellow-countryman at Lokoja, and that although he was the only man in Ilorin who could make these pots, a great many men were employed in similar work at Kura, near Kano.

In Plate 6, fig. 2, the potter is shown at work before his house; it should, however, be stated that under ordinary circumstances he worked under cover, but that on this occasion he had brought his tools and paint-pots into the open air on purpose to be photographed.

The clay, *yimbu*,[1] he used was of a bluish colour and of a gritty character; it was procured, according to his account, from a hole in the ground on the road to Sobe, and mixed with horse-dung before use. Taking a lump of this moist clay, he rolled it between his hands and then flattened it out with his palm on a mat at his side, on which he had strewn a gritty grey powder consisting of felspar, also called *yimbu*. Then, lifting the flat cake, he pressed it down over a wooden mould, to shape it into a lamp bowl. When he had pressed it evenly over the surface he took a thin strip of iron and, running it quickly round the mould, cut off the lower ragged edge of clay. The powder evidently prevented the clay from adhering to the mould, for he was then able to lift off the bowl and lay it aside to dry. Large vessels decorated with the figures of birds and antelopes, which are his speciality, are made in many separate pieces which are partly dried and then joined together before the whole is fired.

After being moulded the vessels are laid out to dry in the sunshine for a day. Their surfaces, after having been rubbed smooth with a string of beads, the seeds of the "Kuka" tree (*Adansonia digitata*, the baobab), are painted with a pink paste, *bakua*, made by grinding down a soft pink stone with water. The vessel is then laid on a layer of sticks and covered with dry grass for firing. Finally it is painted. The potter had four pigments in little dishes, in each of which was a small feather to apply the paints:

1. White, *alli*.[2] Obtained by powdering calcined bones.
2. Blue, *shuni*.[3] The same colouring matter as is used to dye cloths.
3. Green. A crystalline dye of European manufacture bought in the market.
4. Red, *garura ja*.[4]

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[1] "'Yimbu,' 'yambu,' clay, mud." *Dictionary of the Hausa Language*, by Charles Henry Robinson, 1906, vol. i.

[2] "'Alli,' chalk or white earth used for bleaching thread," *ibid*.

[3] "'Shuni' or 'juni,' blue colour, indigo," *ibid*.

[4] "'Garura,' a red dye, brought as a powder from the East"; "'*ja*,' pl. 'jajaye,' red," *ibid*.

The pigments are mixed with *karo*[1] (obtained from a tree called *mareji*) in order to make a suspension to paint over the vessels. The potter was particular in insisting that the paints should be applied in the order given above. The whole vessel receives a preliminary coat of white, after which the decorations are added—first the blue, then the green, and lastly the red. He sometimes uses also a black pigment made from soot. When the pot is painted it is allowed to dry, but is neither glazed nor fired again nor otherwise further treated. The decorations tend, therefore, to be smudged or obliterated by handling.

Prof. Ure has pointed out to the writer that vessels such as that shown to the left of the potter in Plate 6, fig. 1, offer an interesting parallel to some Greek vases identified by Bosanquet, Kourouniotes, and others as *kernoi*. Prof. Bosanquet,[2] indeed, alludes to the possibility that these vessels may have been used as lamps as perhaps worthy of consideration, but they appear to have been accepted as *kernoi* by later writers. The Greek *κέρνος* "was a clay vessel, to which were attached a number of small cups containing various grains and liquids, offered as first-fruits of the harvest, especially in the Eleusinian worship."[3] There is reason for believing that lights were placed upon the *kernos*, and were an essential part of it. The evidence is quoted by Xanthoudides,[4] who points out that the use is perpetuated to this day in the rites of the Orthodox Greek Church.

The bowls on the Nigerian vessels are explained by the natives as lamps, and in the specimens seen by the writer at Ilorin, a shallow indentation or lip for the wick was invariably present on the rim. It is difficult, however, to believe that such vessels could be commonly used as lamps, and in fact the writer was led to understand by the natives that they were mainly ornamental. Several examples of these vessels are included in the Ridyard collection at the Liverpool Museum which are said to have come "from Lokoja, Burutu, Baro, and Bida, N. Nigeria," and it is interesting in this connection to note that in them the bowls are without lips, and have therefore lost their distinctly lamp-like form. In one specimen, indeed, the bowls, which are constricted at the mouth, have distinct shoulders, and the edges are extended and flattened into flange-like rims. The changes in the form of these lamps suggest perhaps that in Nigeria at the present day a development is taking place from one use to another. This again suggests the possibility that the vases published by Bosanquet, Xanthoudides, etc., may have developed from lamps by the differentiation of the bowls so as to serve as receptacles for offerings, "the subsequent multiplication and consequent modification of the cups" being explained, as suggested by Prof. Bosanquet, "by the tendency of barbaric art to magnify and elaborate simple articles for the sake of display, and without any regard to practical convenience."[1]

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[1] "'Karo,' 1. a kind of gum put in ink; 2. 'karon maje,' a sort of gum drawn from a tree and used for perfumes," *ibid.*

[2] R. C. Bosanquet, *Annual of the British School at Athens*, No. III. p. 59.

[3] S. Xanthoudides, "Cretan Kernoi," *Annual of the British School at Athens*, No. XII. p. 9. References to other papers on this subject will also be found here.

[4] *Annual of the British School at Athens*, No. XII. p. 19: see especially the scholiast on Nikander; "'kernoi' are the mystic kraters on which they set lamps."

GENERAL NOTICES RESPECTING ECONOMIC PRODUCTS AND THEIR DEVELOPMENT

SOME COMMON SPICES

It is sometimes stated that commerce in spices is no longer so important as formerly, but this is only true in the sense that the industry is now not restricted to a few centres of cultivation, but is widespread, whilst the marketing of spices is done in many importing centres instead of being confined to a few important markets, as in former times. Probably the total production of spices at the present day is greater than at any former time, though the profits obtained by planters are probably less, since now no single area has a monopoly in the production of any one spice.

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[1] Xanthoudides, however, would derive *kernoi*, libation-tables, tables-of-offerings, and altars from a common prototype, *loc. cit.* p. 15.

One of the most interesting developments in the utilisation of spices in comparatively recent times is in connection with the manufacture of liqueurs, for which large quantities of certain kinds of spices are required. As a rule liqueurs are essentially solutions in alcohol of certain kinds of volatile oils obtained by the distillation of spices. Examples of liqueurs of this kind are "kümmel" and "anisette," which contain respectively caraway and aniseed oils. Apart from this and other methods of using spices for direct or indirect human consumption, considerable quantities of these products are used as flavourings for cattle foods and in veterinary medicine, and familiar examples of this use are fœnugrec and coriander.

By far the largest production of spices takes place in the tropics, since such important materials as ginger, cloves, vanilla, and the peppers can only be grown in such regions, but in addition there are large areas in the temperate and sub-tropical regions devoted to such spices as dill, coriander, cumin, anise, and caraway.

It is proposed in the present article to direct attention to certain of these products which are worth the notice of planters. It must be borne in mind, however, that the cultivation of these materials can never be a great industry, that the supply can easily overtake the demand, and that consequently cultivation should at first be begun on a small scale, and that every effort should be made to produce materials of particularly fine quality, which will readily command a market.

With the exception of fœnugrec, most of these common spices are derived from plants belonging to the natural order Umbelliferæ.

Most of these plants are grown as field crops on a large scale, others are met with in gardens or occur in a semi-wild state. Their cultivation presents no great difficulties, and they are therefore useful as temporary crops or for rotating with crops ordinarily grown in field or garden. Except in the case of fœnugrec, where the seeds proper are employed, the fruit, which is commonly termed the seed as, for instance, in the case of caraway "seed," constitutes the spice. The fruit of umbelliferous plants is known botanically as a schizocarp, and when ripe it generally splits longitudinally into two partial fruits or mericarps. Each half of the fruit has usually five longitudinal ribs, between which four secondary ribs may be present; furrows (valleculæ) occur between the ridges, and beneath each furrow is usually an oil-duct (vitta) which extends the whole length of the fruit. Contained in the oil-duct is a volatile oil, and it is to this that the fruits owe their aromatic properties and their value as spices. A fatty oil is also present in the seed.

In warm countries spice-yielding umbelliferous plants are usually treated as annuals; that is to say, the sowing and harvesting of the crop takes place in one year; but in temperate climates they are sometimes grown as biennials, the seeds being sown during the summer of one year and the crop harvested during the year following. It is usual to harvest the crop before the fruits are thoroughly ripe, in order to give a bright appearance to the spice, and also to avoid loss of fruits, which occurs on handling plants that are thoroughly ripe and dry. In some cases, however, the semi-ripe fruits have a disagreeable odour, which is lost on attaining ripeness, and in such cases the crop must be allowed to ripen thoroughly before harvesting. The fruits form the best spice when they are dried rapidly without artificially raising the temperature, as exposure to high temperatures is liable to cause a loss of the volatile oil.

The Indian export of the essential oil-seeds now under consideration for the past three years for which figures are available, is shown in the following table:

	1909-10.		1910-11.		1911-12.	
	Quantity. cwt.	Value. £	Quantity. cwt.	Value. £	Quantity. cwt.	Value. £
Aniseed . .	775	758	922	735	1,579	1,354
Coriander . .	68,887	41,049	83,379	72,004	89,688	58,694
Cumin . . .	23,936	38,450	28,090	45,045	25,330	39,983
Dill . . .	10,838	5,046	18,540	8,712	8,486	4,026
Fœnugrec . .	11,362	5,383	146,363	73,710	30,972	17,013

The Straits Settlements, Ceylon, and the United Kingdom, in the order named, are the countries in the British

Empire that take the Indian export in the largest quantities, whilst amongst foreign countries Germany is by far the largest importer.

The value of the exports of some of these products from Morocco in 1909 is shown in the following table:

	£
Coriander	9,481
Cumin	11,836
Fœnugrec	41,354

CARAWAY

Caraways, or caraway "seed" of commerce, is the fruit of a biennial herb known botanically as *Carum carvi*, Linn. It is native to Northern and Central Europe, and is extensively cultivated in Holland, Germany, and Russia, and to a small extent in England. It has been introduced to the United States of America, where it is grown as a garden crop. In Holland the area under caraway has been greatly extended recently, and in 1911 was stated to be 20,570 acres; in 1912, however, the area was less than half that in 1911, as, owing to the dry summer of the preceding year, which was unfavourable to caraway, the greater part had to be ploughed up. The caraway plant has usually a fleshy root resembling that of a parsnip, but smaller, and a slender branched stem that attains a height of from 1½ to 2 ft.; the compound, pinnate leaves are divided into very narrow segments; the small white flowers are borne in flat umbels; the fruit when ripe splits into two narrow, elongated carpels ⅙ in. long, pointed at the ends, and with five longitudinal ridges on the surface.

Soil and Cultivation.—Caraway may be grown in a variety of soils, and succeeds well in a medium clay, but a moderately light soil, that has been well tilled and is rich in humus, gives heavier yields and is probably the most suitable for the crop. In the Netherlands, and even in the extreme northern region of Scandinavia, this crop can be grown without difficulty. The Dutch seed is considered the best, and fetches the highest price on the market. The methods of cultivation in Holland are briefly as follows. The caraway plant, being a biennial, does not produce seed until the second year after sowing, and it is usual, therefore, to cultivate it as a mixed crop, sowing with it some other crop that can be harvested the first year, care being taken to choose for this purpose a crop that does not grow high enough to unduly shade or choke the caraway plants. The dwarf kinds of pea are commonly employed in Holland as a companion crop, as also are mustard, poppy, field and other beans, flax, and white clover. The caraway and companion crop seeds are sown about March or the beginning of April, either simultaneously or separately. The seeds are usually sown in straight rows from 12 to 16 in. apart, at the rate of 5 to 8½ lb. per acre. After the seed has germinated the soil receives shallow cultivation by hoeing between the rows, and as soon as the companion crop has been harvested, hoeing is renewed and all weeds and foreign growths are destroyed. Towards the end of the first year the soil is drawn towards the plants to protect the crowns during the winter. A dressing of stable manure, or silt taken from ditches and canals, is also applied, and, in the event of the crop being in a weakly condition, a dressing of nitrate of soda is given. As soon as growth commences in the spring of the second year, the ground is hoed and weeded and the surface soil is kept in a loose condition. If well cultivated the plants grow rapidly and commence to flower about the second half of May. The fruits ripen about the end of June or beginning of July.

Harvesting.—This requires to be done with care, as the fruits are easily detached from the plants when ripe, and a part of the crop is liable to get lost if carelessly handled. On this account the plants should be harvested before they are quite ripe. The usual method is to cut the plants with a scythe or sickle or by means of a reaping-machine. The cut stems are tied into loose sheaves, which are placed together in small stacks of from twenty to thirty sheaves and allowed to dry for a week or two, when they are either removed to barns for storage or are threshed in the field.

If this crop has been allowed to become ripe before being cut, the early morning or evening should be chosen for harvesting, as then the dew is on the plants and the seeds fall less readily than in the hottest part of the day. The crop is secured by placing the stems on a large cloth spread on the ground and beating them with a flail, or by means of an ordinary steam threshing machine.

Yield.—The yield of seeds from rich ground is about 20 cwt. per acre. In Holland it varies considerably, and is frequently from 6 to 16 cwt. per acre; in 1909 the average for the whole country was 9½ cwt. (*i.e.* ten bales: one bale = 110 lb.) per acre. The straw, from 16 to 24 cwt. per acre, is used as fodder or litter for cattle.

Uses.—Caraway is largely used as a kitchen spice and in confectionery, and is also ground up and used in the preparation of curry powders. It is also largely distilled for the volatile oil it yields, which is used in the preparation of liqueurs, such as kümmel, and in confectionery and medicine.

The spice is known on the market by the name of the country of origin, as, for instance, English, Dutch, German, and Mogador seed. The Dutch seed is considered the best for distilling, but Norwegian and East Prussian kinds are also used for this purpose. The yield of oil varies according to the geographical source of the seed. The following figures, quoted from Sawer's *Odorographia*, show the percentages of oil yielded by various kinds of caraway seeds:

German	3·5–5·0	Austro-Hungarian:	
„ (Dutch seed)	4·0–4·3	Styrian	6·0
Bavarian, wild	6·5–7·0	Galician	4·5
East Prussian	5·0–5·5	Moravian	4·0
Wurtemburg, wild	5·5–6·0	Tyrolese, wild	6·5
Hessian	6·0–7·0	Russian	3·2–3·6
Norwegian, wild	5·0–6·5	Finnish	5·0–6·0
Swedish	4·0–6·5	Dutch, East Frisian, wild	5·5–6·0

An inferior oil is said to be sometimes obtained by distilling the husks and stalks that remain after threshing. This is known as "caraway chaff oil," and is used for scenting common soaps.

In Germany the exhausted comminuted seed is dried in a special apparatus and used as fodder for cattle. This fodder has been analysed at the Royal Saxon Agricultural Station, Möckern, and has been found to contain from

20 to 25 per cent. crude protein (75 to 85 per cent. of which is digestible) and 14 to 16 per cent. of fat (Gildemeister and Hoffmann in *The Volatile Oils*). The current price of good Dutch caraway is 33*s.* 6*d.* to 35*s.* per cwt.

ANISEED

Anise or aniseed is the fruit of *Pimpinella Anisum*, Linn., an annual plant indigenous to Asia Minor and Egypt, and cultivated in Spain, Malta, Cyprus, Greece, Southern Russia, and in other parts of Europe where the summer is sufficiently warm to mature the seed. The aniseed plant is a herb, from 2 to 3 ft. high, with cordate radical leaves and biternate, toothed stem leaves. The small yellowish-white flowers are produced in many-rayed umbels that have no involucres. The fruits do not split into two portions as a rule, but are usually seen entire; they are greenish-brown, ovoid, ⅛ in. long, narrowed towards the top, and surmounted by a pair of short styles; the slender pedicel or stalk is usually persistent. The outer surface is marked by ten longitudinal ridges and is covered by minute hairs. The Russian seeds are smaller than those of other varieties. The European market is supplied principally by Russia, Germany, Scandinavia, Bohemia, Moravia, France, the Netherlands, and Spain.

Soil and Cultivation.—The aniseed plant grows readily from seed drilled in a good loamy soil in rows at such a distance apart as will admit of tilling the soil between, either by horse- or hand-hoes.

Sowing should take place in early spring, as soon as the soil and climatic conditions prove favourable for the operation; the crop then ripens in the autumn of the same year. It is important to keep down, by surface tillage, all weeds and foreign growths after the seed has germinated, as, if left, the weeds become mixed with the aniseed crop at the time of harvest, and the two are threshed together. The presence of weed-seeds in consignments of aniseed lowers the value of the latter considerably. In order to obtain aniseed of bright appearance it is advisable to harvest the crop as soon as the earliest seeds are ripe and before the whole crop has become fully mature. The crop is cut with a scythe or sickle and is threshed by means of a flail, a sail-cloth being spread on the ground to collect the seed. After being dried the seed should be stored in bags.

Uses.—Aniseed is used, but not to any great extent, directly as a spice; it is valued chiefly on account of the volatile aromatic oil which it yields on distillation. Germany is the largest consumer of aniseed for distilling anise oil, but the industry is said to have declined during recent years, partly owing to the high price of Russian aniseed and to the competition of pure anethole, which can now be prepared from other raw materials. France also employs considerable quantities in the preparation of such liqueurs as Ratafia d'anis, Anisette, etc., and in Spain and Austria it is used in considerable quantities for flavouring purposes.

The following table, quoted in Sawer's *Odorographia*, gives the percentage of essential oil obtained from the principal commercial kinds of aniseed:

Moravian	2·6	Levantine	1·3
Chilian	2·4	Spanish	3·0
Thuringian	2·4	Russian	2·8

A similar volatile oil is obtained from Chinese star anise, the fruit of *Illicium verum*, Hook., a shrub belonging to the N.O. Magnoliaceæ and of no botanical affinity to Pimpinella (see p. 159). In Australia the fruits of an umbelliferous plant known as *Sesili Harveyanum* are said to be used as an aniseed substitute.

In Germany the residue of distilled aniseed is dried and used as cattle food. According to analyses made at the Saxon Experimental Station, Möckern (quoted in *The Volatile Oils*, by Gildemeister and Hoffmann), the aniseed residues contain 17 to 19 per cent. of protein and 16 to 22 per cent. of fat.

The principal supplies of aniseed are obtained from Russia, Spain, and the Levant. There is also a small export from Cyprus (460 cwt. in 1909).

The current price of aniseed on the London market is: Fair Russian 26*s.* 6*d.* per cwt., Fair Spanish 35*s.* per cwt.

CORIANDER

The plant which yields the coriander seed of commerce is *Coriandrum sativum*, Linn. It is native to Central Europe and the Levant, and is now cultivated in many countries, especially in Moravia, Thuringia, and Russia, whence comes the bulk of the European supply. As a cultivated plant coriander is found all over India, and the spice is exported in considerable quantities, the trade showing an increase during recent years. It is grown in the south of England to a small extent, being sometimes mixed with caraway, the coriander yielding a crop the first year and the caraway during the years following. The coriander plant is an annual herb 1 to 2 ft. high, with a much-branched stem furnished with finely divided leaves. The small flowers, borne in terminal umbels, are of a rose-white colour; the fruit is globular in shape, with the remains of two stigmas projecting from the top; it easily splits into two halves, the inner sides of which are concave. Before it is ripe the fruit has an unpleasant odour. When ripe and dry it is pleasant to the taste and aromatic.

Soil and Cultivation.—In warm countries the sowing takes place during the cold or rainy season; the seed is sown broadcast in sandy loam or black soil. It takes from three to four months to ripen, and the crop requires to be weeded once or twice during that period. In India the seed is sown broadcast after being first rubbed between the hands to separate the halves (mericarps) of the fruits. The sowing takes place at various seasons in the different provinces: in Bengal and the United Provinces the seed is sown during the cold season, in Bombay during the rainy season, and in Madras during the autumn. The seed germinates in about three days, and requires only two weedings. In about a month from sowing the seed has formed, and after it has ripened the plants are pulled and the crop obtained by threshing with a flail, or it is trodden out by bullocks. After being dried in the sun the seeds are stored in bags.

In European countries the seed is sown in September in drills a foot apart, preferably in light, rich soil; about

15 to 20 lb. of seed is required to sow an acre. The young plants are thinned to about 6 or 8 in. apart in the rows. In spring the soil is hoed to keep down weeds. The flowers appear in June and the seed ripens during August. On account of the disagreeable odour of the unripe seed, it must be allowed to remain on the plants until thoroughly ripe. To avoid loss by handling it is advisable to harvest the crop by cutting off the seed-bearing umbels and placing them in bags, rather than to cut down the whole plant. The seed is easily obtained by lightly flailing the plants or umbels in the field—a cloth being spread to receive it.

The average yield from good soil is about 15 cwt. per acre.

Uses.—In Eastern countries coriander enters largely into the composition of curries; it is also valued in medicine, and is used for flavouring spirits. The chief value of coriander in Europe is as a source of an essential oil, which is obtained by steam distillation, and coriander from Moravia, Thuringia, and Russia is chiefly used for distilling. The following figures quoted from Sawer's *Odorographia* give the percentages of oil yielded by various kinds of coriander seeds:

Moravian	0·8	**German (Thuringian)**	0·6 to 0·8
Dutch	0·6	**Italian**	0·5
East Indian	0·2	**Morocco**	0·2 to 0·6
French	0·4	**Russian**	0·8 to 1

The residue after distillation is used as a cattle food. It contains 11 to 17 per cent. of proteins and 11 to 20 per cent. of fat.

Coriander from the East Africa Protectorate

Two samples of coriander seeds were received for examination at the Imperial Institute from the East Africa Protectorate in November 1911. They were labelled as follows:

"No. 1. Grown in the Kyambu district from seed obtained from India. Harvested about the beginning of October."

"No. 2. Grown in the Kiu district from seed obtained from India. Harvested about the middle of September."

On distillation the samples yielded 0·14 and 0·05 per cent. of oil respectively. The oils were found to have the following constants as compared with commercial coriander oil :

	Sample No. 1.	Sample No. 2.	Commercial oil.
Specific gravity at $\frac{15^\circ C.}{15^\circ C.}$.	0·8781	0·8726	0·870 to 0·885
Optical rotation in 100 mm. tube at 20° C. . .	+ 11° 47′	+ 9° 5′	+ 8° to + 13°
Solubility in alcohol .	Soluble in 1·8 volumes or more of 70 per cent. alcohol.	Soluble in 1·5 volumes or more of 70 per cent. alcohol.	Soluble in 3 volumes or less of 70 per cent. alcohol at 20° C.

The samples were submitted to a commercial expert for valuation, and he reported that they would not be of any value for distillation purposes on account of the low percentage of oil they contained, and that they could only be used as cattle spices, etc. For this purpose sample No. 1 would be worth from *7s.* to *8s.* per cwt. and sample No. 2 from *6s.* to *7s.* per cwt. (July 1912).

Possibly a better oil-yield would have been obtained had Russian or Thuringian varieties been grown, as they usually contain a larger percentage of oil than Indian kinds.

Cumin

Cumin, or cummin, is the dried fruit of *Cuminum Cyminum*, Linn., an annual plant native to Egypt and the Mediterranean region, and found in cultivation in Arabia, India, and China. The plant is said to ripen its seeds as far north as Norway, but Morocco, Malta, and Sicily furnish the chief supplies.

The cumin plant is a slender annual, 1 to 2 ft. high, with twice or thrice tri-partite leaves deeply cut into filiform segments ; the fruits resemble those of the caraway plant, but are larger and lighter in colour and have nine ridges on each half (mericarp).

"Black cumin," which is extensively cultivated in India, is the seed of *Nigella sativa*, a ranunculaceous plant native to Southern Europe, and quite distinct from true cumin.

Uses.—Cumin seed was formerly used as a common flavouring spice in England, and is so employed in Germany at the present time, but elsewhere in Europe it has been largely replaced by caraway. In Holland it is said to be used for flavouring cheese. It is largely used as a spice and curry ingredient in India, where considerable importance is also attached by natives to its medicinal properties. In Europe the medicinal use of cumin is confined to veterinary practice. The seeds are powerfully aromatic, but are hotter and far less agreeable to the taste than caraway. They yield a volatile oil, known as "oil of cumin," which is employed in European countries in the manufacture of liqueurs. The following table, quoted from Gildemeister and Hoffmann's *Volatile Oils*, gives the percentage of oil obtained from the principal commercial kinds of cumin seed used for distilling:

East Indian	3·0–3·5	Morocco	3·0
Maltese	3·5	Syrian	2·5–4·0

Germany is by far the largest consumer of cumin; France and Spain rank next, in the order named. A considerable quantity of cumin seed is exported from India, the United Provinces and the Punjab being the chief producing provinces. The modern traffic is almost exclusively from Bombay and Bengal, the exports being consigned for the most part to Ceylon, the Straits Settlements, and British East Africa. India also imports considerable quantities of cumin seed across the North-Western land frontier and from the Red Sea and Persian Gulf ports. The chief trade centres are Jubbalpur, Gujarat, Rutlam, and Muscat.

The Indian exports for the past three years are shown in the table on p. 123.

In Malta the area under cumin in 1911–12 was returned at 1,594 acres, and the produce (13,256 cwt.) was exported chiefly to France (5,075 cwt.), Italy (4,100 cwt.), Germany (1,512 cwt.), Holland (668 cwt.), and the United Kingdom (645 cwt.). The value of the total export was £14,374.

The exports of cumin seed from Morocco for the year 1909 were valued at 295,897 francs (£12,329).

The current price of cumin in London is as follows; Good Morocco, 25*s.*; Fair Malta, 22*s.* per cwt.

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DILL

Dill is a glabrous herb indigenous to Central and Southern Europe, but found abundantly in other countries, its range extending from Spain to the Caucasus and Persia, and southwards into Egypt and Abyssinia. It is also found throughout tropical and sub-tropical India, and is cultivated to a small extent in England. The plant is known botanically as *Peucedanum graveolens*, Benth. (syn. *Anethum graveolens*, Linn.), and is distinguished by the absence of an involucre to the inflorescence. It grows to a height of from 2 to 2½ ft., and has glaucous-green, hollow, branching stems, furnished with finely-cut bi- or tri-pinnate leaves. The compound umbels of small yellowish flowers are followed by fruits that are flattened from back to front, and have a membranous border or wing; the ridges are six in number, three of which occur on each half (mericarp) of the fruit.

In European countries the seed is usually sown in autumn in warm positions in light, well drained soil, either broadcast or in drills 6 to 12 in. apart. The young plants are thinned in spring to about 10 in. apart, and the soil is hoed and kept free from weeds. Harvesting is effected as soon as the seeds are mature, in the manner already described for similar plants of this family. In India it is cultivated as a cold weather crop, and is sometimes met with as a weed of cultivation. The form grown in India differs slightly from the European plant in having a fruit a little longer and more narrowly winged. By some botanists this is considered a distinct species, and it has been named *Peucedanum Sowa*, Kurz (syn. *Anethum Sowa*, Roxb.). The essential oil obtained from this plant also differs from that derived from the European species.

Uses.—In India the leaves are cooked as a pot-herb along with other vegetables. In Europe the seed is distilled for the volatile oil it contains. The following table, quoted from Sawer's *Odorographia*, gives the percentages of oil obtained from the principal commercial kinds of dill seed:

German	3·8	East Indian	2·0
Russian	4·0	Roumanian	3·5

The seeds are also employed as a condiment, specially for pickling with gherkins, and in the north of France they are often used for flavouring winter preserves. Dill oil is used to a considerable extent in medicine as a carminative. According to Gildemeister and Hoffmann (*loc. cit.*), the dried distillation residues contain 14·5 to 15·6 per cent. of protein, and 15·5 to 18 per cent. of fat, and are used as a cattle food.

Dill from the East Africa Protectorate

Two samples of dill seed were received for examination by the Imperial Institute from the East Africa Protectorate in January and July 1910 respectively. The second sample was stated to have been grown at Limoru at an altitude of 7,000 ft. On distillation the samples yielded 2·8 and 2·06 per cent. of oil respectively. An examination of the oils gave the following results compared with oil from European dill:

	Oil from East African seed.		Oil from European seed.
	Sample No. 1.	Sample No. 1.	
Specific gravity at 15° C.	0·9174	0·9117	0·895 to 0·915
Optical rotation in 100 mm. tube at 20° C.	+ 77° 10′	+ 77° 3′	+ 75° to + 80°
Solubility in alcohol .	Soluble in 1·6 or more volumes of 80 per cent. alcohol.	Gave a clear solution with 6 to 6½ volumes of 80 per cent. alcohol.	Soluble in 5 to 8 volumes of 80 per cent. alcohol.

Commercial experts to whom the samples were submitted for valuation reported that sample No. 1 would probably be worth 18*s.* to 22*s.* per cwt. on the London market (March 1910), and sample No. 2 was valued by one firm at about 34*s.* per cwt. or less, and by another at 27*s.* per cwt. (December 1910).

FŒNUGREC

Fœnugrec or fenugreek of commerce consists of the seeds of a robust, annual, leguminous herb, known botanically as *Trigonella Fœnum-græcum*, Linn. It is native to Eastern Europe and Abyssinia and is cultivated throughout the Mediterranean region and also in Egypt and India. The plant has smooth, erect stems, more or less branched, that attain a height of from 8 to 12 in. or more; the leaves are trifoliate, the leaflets smooth, oblanceolate-oblong, coarsely toothed, and about 1 in. in length; the flowers, produced singly or in pairs in the axils of the leaves, are sessile, small, and of a yellowish colour; the pod is from 1½ to 3 in. in length, linear, more or less curved and pointed; the small seeds are of a rhomboidal shape and brownish-yellow in colour; from 10 to 20 seeds are contained in each pod.

Cultivation.—In India fœnugrec is grown near wells and on lands subject to inundation (*sailáb* lands), a rich alluvium or clayey loam being generally selected. On well lands it is sown in February at the rate of 30 lb. of seed per acre, and the crop is ready to cut in April. On *sailáb* lands it is sown at the end of October or the beginning of November, and the crop ripens about the same time as that grown on well lands.

In Egypt fœnugrec is grown both for fodder and for seed, but the area in Lower Egypt under this crop is small. In Upper Egypt it is usually grown as a mixed crop with vetches, berseem, beans, and barley. When grown with vetches it is invariably eaten off as a green fodder. The seed is sown when the Nile water passes off the land at the end of October or beginning of November, at the rate of four kelahs of seed per feddan (= about 1½ pecks per acre).

In the Delta it is sown in water after ploughing, up to November 20. One or two subsequent waterings are given in the Delta, but in Upper Egypt it is grown without water. When grown with cereals the two crops are harvested and thrashed together, the seed of the fœnugrec being separated later. Under these conditions the yield is about 2 ardebs per feddan (about 10 bushels per acre). When grown pure the yield is from 2 to 4 ardebs per feddan (from 10 to 20 bushels per acre).

In the Mediterranean region it is sown in spring at the rate of from 13 to 16 lb. of seed per acre, preferably after rain. The pods ripen in succession from the base of the plant upwards, and as they dehisce and scatter the seeds it is necessary to harvest the plants as soon as the first-formed pods are ripe, and whilst many of the later-formed pods are still green.

Uses.—The plant is grown as a fodder-crop for cattle, after the manner of lucerne, but chiefly for the sake of its seeds, which have aromatic and stimulant properties. The seeds are used in veterinary medicine and form one of the ingredients of concentrated cattle foods. In the East they are used in curries and are germinated and the sprouts eaten as a vegetable. In the United States of America fœnugrec has been tried as a green manure and has been found especially suitable for coastal regions.

The current price of "Fair Morocco fœnugrec" is 9s. per cwt.

MANUFACTURE OF PAPER PULP FOR EXPORT

Until about the middle of the nineteenth century, paper was manufactured almost exclusively from rags of various textile fabrics. This material is still employed to a considerable extent in the manufacture of better class papers; it yields a paper pulp of excellent quality with no very drastic treatment. Owing, however, to the tremendous development of the paper trade and a deficiency in the supply of rags, it became necessary to find substitutes to supplement this material. Wood, straw, and esparto were among the chief materials put forward in response to this demand, and various methods were devised for the preparation of a suitable paper pulp from them. Numerous other fibrous materials have been exploited from time to time, but only a few of them have acquired any permanent commercial importance.

The conversion of a fibrous material into a pulp suitable for the manufacture of paper consists essentially in the separation of the "ultimate" fibres of the material from their incrusting substances. As a general rule, the more thoroughly this separation is effected the better the quality of pulp produced; but it is essential that the ultimate fibres should not be broken or weakened to any great extent during the process.

Wood Pulp.—Wood pulp is by far the most important paper-making material at the present day, on account of its cheapness, and as a result of the applicability of its various qualities to the manufacture of different classes of paper. The coniferous trees yield soft wood most suitable for pulp, but other varieties of wood are being increasingly employed for the purpose. Recently, extensive investigations as to the treatment necessary for, and the yield of pulp from, various woods have been made by the U.S. Dept. of Agriculture (*Paper Pulps from various Forest Woods*, U.S. Dept. Agric., March 1912).

The pulping process may be either chemical or mechanical, the latter being cheaper, but yielding an inferior product.

In the preparation of mechanical pulp the timber is first sawn into two-foot lengths and the bark removed. The grinding is effected by means of grindstones revolving at a rapid rate, either vertically or horizontally, against the surface of which the logs are forced by hydraulic pressure. The stones are enclosed in casings provided with trapdoors through which the wood is introduced. A stream of water, constantly running through the machine, carries the pulp away to strainers, where it is freed from knots and pieces of wood insufficiently ground. The finely divided pulp passing through is run to a machine, where it is converted into sheets suitable for export.

In the earlier processes for the manufacture of ground wood, the wood was applied to the stone in such a manner that the surface of the stone ground across, not along, the grain of the wood; the resultant product was practically a powder, possessing little felting power, and of little use for the manufacture of paper. In the more modern processes, however, the wood is pressed against the revolving stone so that the fibro-vascular bundles are torn away entire, not cut transversely.

Mechanical wood pulp loses its felting power to a considerable extent if it is stored dry for any length of time. It is for this reason that most of the mechanical pulp imported into this country is imported in a moist condition.

The chemical pulping of wood is essentially a process of digestion of the chipped wood with a disintegrating chemical solution under pressure at a high temperature.

In the "sulphite" processes the liquor employed consists of an aqueous solution of "bisulphite" of lime or magnesia. It is usually prepared by passing sulphurous acid gas (produced by burning sulphur or pyrites) up towers packed with lumps of limestone or dolomite through which water is trickling. The digesters commonly employed are of steel, lined with lead or acid-resisting brick, or with a combination of these two materials. The actual digestion may be carried out by one of two methods, the "quick" or the "slow" (Mitscherlich) process. In the former the pressure employed is 65 to 85 lb. per square in. and the digestion seldom occupies more than 16 hours; in the latter the pressure never exceeds 45 lb. per square in. and the time occupied is 36 to 48 hours. The sulphite process is the most important of the chemical processes.

In the soda process, the liquor used for digesting the wood consists of an aqueous solution of caustic soda. The concentration of the soda solution and the pressure employed are naturally greater than those required for the pulping of such materials as esparto and straw. The pulp produced is of good quality and is especially suitable for the manufacture of certain classes of paper. Owing to the cost of the caustic soda, this has to be recovered by evaporation of the liquors and recausticising the residue with lime.

A chemical process which is finding increasing popularity is the "sulphate" process. The initial liquor used consists of a solution of a mixture of sodium sulphate and sodium hydroxide (caustic soda), the loss of chemicals being made up by the addition of more sodium sulphate.

Chemical wood pulp is of much better quality than that produced mechanically, and fetches a considerably higher price. Most of the chemical pulp is imported into this country in the dry state, as the loss of felting power which takes place with mechanical pulp does not occur with this product.

Esparto.—Esparto is another paper-making material of importance. It is usually exported from its country of origin in compressed bales, comparatively little being exported as pulp. It is a grass, or more correctly a sedge, which grows wild over large tracts in Spain and Northern Africa. It was introduced into this country as a paper-making material in the middle of the last century by Thomas Routledge, and rapidly attained great popularity; in 1862 it was the chief ingredient of most English newspapers. The pulping of esparto is carried out with caustic soda solution in digesters provided with a "vomiting" device, which prevents the grass collecting in masses and being, in consequence, unevenly digested. As will be seen from the following table, the import trade in esparto grass does not show the same rapid progress as that in the better-class wood pulps.

Imports of Esparto Grass and Wood Pulp to the United Kingdom

Year.	Esparto grass and other vegetable fibres.	Wood pulp (total).	Year.	Esparto grass and other vegetable fibres.	Wood pulp (total).
	Tons.	*Tons.*		*Tons.*	*Tons.*
1902	198,292	525.799	1907	202,523	672,499
1903	179,089	576,153	1908	192,975	748.434
1904	200,245	569,245	1909	197.501	742.739
1905	191,114	578,012	1910	193,218	859.953
1906	188,192	606,811	1911	201,636	754,296

Straw.—Large quantities of straw pulp are imported into this country for the manufacture of brown papers and straw boards. The straw, chopped into pieces of about 2 in. in length, is heated with caustic soda in horizontal rotating digesters. The yield of pulp from the straws of wheat, barley, oats, and rye, which are most commonly employed, varies from 40 to 45 per cent.

Bamboo.—Bamboo is now coming into commercial prominence as a source of paper pulp. The Chinese have long employed it for the manufacture of their native paper, but though it had attracted the attention of investigators from time to time, the drastic treatment necessary to disintegrate the nodes of the mature canes had prevented its commercial success. Routledge, the pioneer of the esparto industry, suggested in 1875 the use of young canes, which when treated with hot, dilute alkaline lye and subsequently washed and dried, would yield a fibrous, tow-like mass which could be compressed into bales and exported in this form. Investigations on the utilisation of bamboo have recently been carried out by Sindall (*Manufacture of Paper Pulp in Burma*, 1906, and *Bamboo for Paper Making*, Marchant Singer & Co., 1909), and Raitt (*Indian Forest Records*, 1912, **3**, Pt. iii, 1). Sindall recommends the removal of the nodes from the canes before digestion; an evenly digested pulp is thus assured. Raitt has shown that a previous crushing and treatment of the canes with hot water avoids the necessity of removing the nodes, and also effects a saving in the time of digestion and the consumption of chemicals. The estimated cost of production of a ton of unbleached pulp is about £6, so that in the Far East bamboo pulp can compete with wood pulp imported from America.

Many other materials besides those already mentioned yield excellent paper pulps. In America the "fuzz" remaining on cotton seeds after the removal of the lint is used to a considerable extent and yields paper of excellent quality. "Bagasse," or "megasse," the fibrous residue obtained after the removal of the juice from the sugar-cane, yields a paper pulp which appears likely to become an article of commercial importance (see this BULLETIN, 1910, **8**, 151). A process has recently been devised whereby a higher yield of sugar is obtained from the cane and the fibres are left in a more suitable condition for pulp manufacture (*Paper Maker's Monthly Journal*, 1913, **51**, 8).

Numerous other materials which yield paper pulp are described in *Selected Reports of the Imperial Institute, Part I., Fibres*, and this BULLETIN (1912, **10**, 372, this Vol., pp. 68, 163).

It does not follow that because a fibrous material yields a good paper pulp it can be employed for this purpose on a commercial scale. If it is to be converted into pulp in the country of origin, there is the question of available power and supply of chemicals for the pulping processes; if it is to be exported in its raw condition, the cost of transport often proves a serious obstacle, owing to the bulky nature of many of these materials. In any case the cost of production must be kept down to such a level that it can compete with wood pulp and esparto in the market in which it is placed. The price of unbleached chemical wood pulp in London is £7 10*s.* to £8 12*s.* 6*d.* per ton for pulp prepared by the soda process, and £8 5*s.* to £8 10*s.* per ton for that prepared by the sulphite process (February 1913); the price of North African esparto grass in London ranges from £3 2*s.* 6*d.* to £3 12*s.* 6*d.* per ton, and that of Spanish esparto grass from £4 10*s.* to £5 2*s.* 6*d.* per ton. Further, it is absolutely necessary, if a raw material is to attain any commercial importance as a source of paper, that a large and constant supply should be forthcoming.

GENERAL NOTES

Sisal Hemp Cultivation in German East Africa.—Although the cultivation of Sisal hemp in German East Africa has not yet been in progress for quite twenty years, the industry has already attained an important position. Some interesting information on this subject has been furnished by Dr. W. F. Bruck, who has recently made a tour of the country (*Verhandlungen des Vorstandes des Kolonial-Wirtschaftlichen Komitees*, 1912, No. 2, 39).

In 1911, 11,212 metric tons of Sisal hemp were exported, of the value of about £226,000, and it is estimated that the exports in 1912 amounted to at least 16,500 tons, and that ere long the annual exports will reach 20,000 tons. The cultivation is not limited to particular districts of the Protectorate, but can be carried on under widely different conditions of soil and climate.

The plantations are usually made by means of suckers of various sizes up to 18 in. On soils which are not too rich in nutritive constituents or humus, the leaves can usually be cut for the first time after three years, and can be gathered subsequently for from five to seven years. If the soil is particularly rich, as in the Usambara District, the plants are ready for cutting after about eighteen months, but afterwards only live for about three years. On poor soils, on the other hand, the agaves do not yield mature leaves until four or five years from the time of planting, but the life of the plant is usually longer than in other cases. In general, however, whatever be the nature of the soil, the plant yields during its life about 200 leaves for fibre extraction, and the leaves furnish about 3½ to 4 per cent. of their weight of fibre.

In order that a Sisal hemp estate may be developed in the most profitable manner, an extensive area of land is necessary. It must be borne in mind that an extracting machine, such as the "New Corona," requires 100,000 to 120,000 leaves per day, so that in a year of 300 working days, 30,000,000 leaves should be available. Moreover, it is of importance that land should be available for the creation of new plantations, and that the plans for these should be worked out in a systematic manner, so that there is always a sufficient number of leaves ready for cutting throughout the year.

There are two systems of cultivation in vogue. In one system (the "rational" system) the suckers are regularly removed from the parent plant, whilst in the other they are allowed to remain in the ground and develop naturally. The latter method has the advantage that there are always leaves ready for cutting, and the need of providing new plantations from time to time is thus obviated. It presents the disadvantage, however, that the plantations cannot be cleaned without great difficulty, and that the leaf material, and consequently the fibre, is irregular. Moreover, such plantations suffer much more from the attack of fungi, bacteria, and other pests than do those which are cultivated in the "rational" manner. The weeds and undergrowth grow very thickly, and afford a breeding-place for all kinds of pests. There is the further danger that, in such circumstances, an epidemic might break out or that a degeneration of the plants might take place.

There is no doubt that the "rational" system, in which the plants are properly spaced and the plantations regularly weeded, gives as a rule better results, and particularly in yielding fibre of more regular quality. When no secondary crop is grown between the agaves, the best distances for planting are, on the average, 7 ft. 6 in. by 4 ft., but of course will vary to some extent with the nature of the soil. In districts which are well adapted for cotton, the planting of this crop between the Sisal hemp plants has given good results, but it cannot be recommended for lands which do not possess well marked dry and wet seasons. In general, such secondary crops are more or less detrimental, and are not advisable unless they are of such a nature as to improve the soil. In the case of soils which have become exhausted by the prolonged cultivation of Sisal agaves, it is suggested that leguminous plants should be grown, or that the land should be left fallow for some time.

Recent Developments in Cotton Growing in the United States.—The principal conclusions which have been drawn from recent work on the cotton crop by the United States Department of Agriculture have been summarised in *Circular* No. 96, *Bureau of Plant Industry.*

Improved varieties of American Upland cotton have been produced, and the seed distributed to planters. The Columbia variety, an early-ripening kind with a long, strong, and regular fibre, originated in South Carolina; it has proved to be well suited to extensive areas in the eastern part of the cotton belt, and has given good results in Western Tennessee. The Foster variety, a hybrid between long-stapled Upland and Texas Big Boll, has afforded excellent results in some localities, but appears liable to variation. Other varieties which have proved satisfactory are Lone Star, developed from the Texas Big Boll type, and Trice, a particularly early-ripening, short-stapled form obtained by selection from a local stock, known as Tennessee Green Seed.

Cotton growing is being introduced into the drier parts of Texas and other south-western States; extension in this direction is very desirable, as the boll-weevil effects less damage in a dry climate. Several types of cotton have been introduced from boll-weevil infested regions of Mexico and Central America, and four of these—viz. Kekchi, Durango, Acala, and Tuxtla—have proved very successful; in addition to possessing certain characters which afford some degree of protection against the boll-weevil, they give an abundant yield of cotton of good quality and 1 to 1¼ in. long. The Durango variety is very promising for irrigated districts in Texas and other south-western States; the plant is more resistant to drought than most other long-stapled cottons, and it bears large bolls, which ripen early.

Efforts have been made to induce planters in particular districts to co-operate with the object of producing a single superior variety of cotton. The adoption of this practice would obviate the hybridisation of varieties in adjacent fields, and the mixing of seed in the ginneries would facilitate selection, and would enable a large quantity of cotton to be produced of a uniform character, and consequently of higher value. The necessity for continued selection, in order to maintain the quality of superior varieties, has been confirmed, and improved methods of selection have been devised.

It often happens that young seedlings exhibit malformation of the leaves, and in many cases also lose their terminal bud. Development is thereby retarded, and the yield of cotton is reduced. Advice is given with regard to the cultural methods to be adopted in order to avoid such injuries.

Experiments are being continued on the crosses between Egyptian and American Upland varieties, and also on the propagation of such hybrids by means of cuttings.

Egyptian cotton plants show less tendency to shed their buds and young bolls than those of the American Upland varieties. Another advantage of Egyptian cotton is that the crop is more easily picked than that of Upland cotton, and it is therefore superior as a family crop, *i.e.* a crop worked entirely by the planter and his family. Although Egyptian cotton has been grown successfully in Arizona and Southern California, it cannot be expected to give similar results on irrigated lands in Texas, where quite different conditions prevail; for the latter region, the Durango variety is to be preferred.

Cocoa from Southern Nigeria.—Next to the products of the oil palm cocoa is the most important agricultural product exported from Southern Nigeria, the quantity exported in 1911 being 88,025 cwt., valued at £164,664. In order to demonstrate to the natives the advantage of properly preparing their cocoa, the Agricultural Department recently undertook the preparation of a certain quantity of native-grown cocoa for the market. A sample of the cocoa so prepared was submitted for valuation to a firm of merchants in Liverpool. They reported that it compared favourably with Gold Coast cocoa, and valued the sample at 55*s.* to 56*s.* per cwt., with ordinary Ibadan cocoa at 50*s.* to 51*s.* per cwt., and fine fermented Accra cocoa at 55*s.* per cwt. (December 1912). The firm in question are prepared to buy cocoa of similar quality in Southern Nigeria at prices higher than those paid for ordinary native cocoa.

The Agricultural Possibilities of the Panama Canal Zone.—The maintenance in the Panama Canal Zone of a large body of men dependent almost entirely upon outside sources for food, together with the increasing geographical and economic importance of this strip of land, led to an agricultural survey by the United States Department of Agriculture in 1909, and the results of the survey form *Report No.* 95 (1912) *of the Office of the Secretary* of that Department. The Canal Zone extends the whole length of the canal and five miles either side of its median line, and has an area of 450 square miles, of which about 325 square miles will be available for cultivation. The agricultural methods at present practised in this area are very primitive, and the production of the local staple products, principally tropical vegetables and fruit, rice and maize, is little more than sufficient for the needs of the holders themselves.

Owing to the broken topography of the country, large farming operations are impracticable; the best method of development appears to be by a series of small farms, operated by the proprietors themselves or under the management of a central authority. The scheme which promises most success is the development of a permanent mixed tropical agriculture. Among the fruits and vegetables suggested for cultivation are mangoes, avocados, pineapples, and mangosteens, all of which seem well adapted to the local conditions. Staple crops, as maize, cassava, yams, sugar-cane, plantains, bananas, and mountain rice, are already well established. Cocoa, coffee, and rubber are other suggested crops.

Afforestation is proposed for areas not suitable for agriculture. Teak and various species of Eucalyptus are recommended in this connection.

Mineral Output of New South Wales.—The *Annual Report of the Department of Mines, New South Wales*, for 1911, records a total mineral output valued at £9,758,006, an increase of £1,021,537 on that for 1910.

The gold output was valued at £769,353, a decrease of £32,858 on that for 1910, and is the lowest recorded since 1902. The tin produced showed a substantial increase, being valued at £307,089, an increase of £78,933 as compared with 1910. The yield of gold and tin obtained by dredges forms an important item. During the past twelve years the dredges have won 329,704 oz. of gold, valued at £1,400,498, and 10,566 tons of stream tin, valued at £1,049,255. The dredges in operation numbered 71, of which 35 were employed in the recovery of gold, and 36 in winning stream tin.

The coal output increased, and amounted to 8,691,604 tons, valued at £3,167,165, an increase of £157,509; so also did the output of kerosene shale, which amounted to 75,104 tons, valued at £36,980, being an increase of 6,811 tons and £3,084 in value on the figures for 1910.

Among the silver, lead, and zinc mines, notable events were the resumption of work underground at the Proprietary Mine, and the location of a large ore-body at the Thomson section of the British mine. The total value of the silver and silver-lead ore produced was £2,442,764, an increase of £581,285 on the previous year.

The output of copper was valued at £590,102, an increase of £61,520, due to the improved returns from the Great Cobar district which took place in spite of the scarcity of skilled labour.

Diamonds amounting to 5,771 carats, valued at £4,064, were won, the entire yield being obtained from the deposits at and near Copeton. This is an increase of 2,165 carats and £1,183 in value over that in 1910. Opal mining resulted in some rich finds, one stone, weighing 5 oz., being valued at £300. The total opal output was valued at £57,300, a decrease of £8,900, due to a reduction in price of the stone, which caused a number of miners to leave the field and seek employment elsewhere.

Other minerals which show increased production are limestone, alunite, shale, wolframite, platinum, and antimony ore. There were decreases in the output of iron ore, scheelite, molybdenite, and various other minerals of minor importance.

Mineral Output of Queensland.—According to the *Annual Report of the Under-Secretary for Mines, Queensland*, for 1911, the value of the year's output of minerals was £3,661,063, a decrease of £49,159 as compared with 1910.

The value of the gold extracted was £1,640,323, a decrease of £234,627. A notable feature of the year was the disclosure in the Brilliant Deeps Mine at Charters Towers of a strong and rich reef at a depth of 2,500 ft., affording encouraging evidence as to the prospects of deeper working in that field.

The total value of the silver-lead output was £79,765, a decrease of £43,321.

The output of copper was 20,384 tons, valued at £1,151,351, an increase in value of £218,862, making some amends for the decrease in gold and silver-lead.

The uniformly high price of tin during the year proved an incentive to tin-mining, and the output of the metal was 3,091 tons, valued at £307,847, compared with 2,953 tons, valued at £243,271, in 1910. Considerable development took place in the Herberton District, and promising discoveries of ore were made.

In the production of wolframite, molybdenite, and bismuth there was little change; but wolframite declined slightly towards the end of the year, in spite of the satisfactory value of tungsten ores.

The normal output of 1,000 tons of manganese ore at Mount Miller, in the Gladstone District, was maintained, the whole of this being taken by the Mount Morgan Chlorination Works. The Mount Morgan Company's quarry at Marmor produced 92,407 tons of limestone, valued at £17,916.

The gem industry of the Anakie sapphire field was maintained, although no new deposits were found. The population of the field was 511, and the year's output of stones was valued at £24,393. The conditions on the opal fields continued unchanged, the estimated value of the output being £3,000.

The gradual expansion of the coal-mining industry continued. New mines were opened and new machinery introduced. During the year, forty-two collieries produced 891,568 tons, valued at £323,998, being, when compared with the previous year, an increase in the number of collieries of five, in output of 20,402 tons, and in value of £1,176, but a decrease in average value of twopence per ton.

During the year, direct State assistance amounting to £18,000 was given for various purposes in connection with the mining industry.

The Utilisation of Zirconium Minerals. — The zirconium mineral of most frequent occurrence is the silicate known as zircon (ZrO_2,SiO_2), which, when pure, contains 67·2 per cent. of zirconia and 32·8 per cent. of silica. Zircon was formerly the source of commercial zirconia, but it now appears to have been largely displaced by the mineral baddeleyite (zirconia, ZrO_2), which requires comparatively little preparation before use.

Baddeleyite occurs in large quantities in certain gravels of the Serra de Caldas in Minas Geraes, Brazil, and is stated to occur in three forms, the composition of which is shown in the following table:

		Glassy fragments.	Stony fragments.	Pebbles.
		Per cent.	*Per cent.*	*Per cent.*
Zirconia	ZrO_2 . . .	94·12	88·40	74·48
Titanium dioxide	TiO_2 . . .	0·98	3·12	1·35
Ferric oxide	Fe_2O_3 . .	3·22	4·07	10·26
Silica (free)	SiO_2 . . .	0·43	2·50	14·08
Silica (combined)	SiO_2 . . .	1·98	3·39	

The glassy variety can be freed from most of its ferric oxide by mechanical means, yielding a product which contains about 98 per cent. of zirconia. Various grades of prepared powdered zirconia are now offered for sale at the following rates:

Percentage composition.	Price per metric ton.
Zirconia, 90 to 92; ferric oxide, 1·0; silica, 8·0 . .	£35
„ 90 to 92; „ „ 7·0; „ 1·0 . .	£36
„ 98·00; „ „ 0·8; „ 1·0 . .	£50

Probably the largest field for the utilisation of zirconia is its employment as a refractory material for crucibles and furnace hearths. Various methods of preparing these have been described. In one of these methods a mixture consisting of 90 parts of zirconia with 10 parts of magnesia is used, and made into a paste with 10 per cent. of phosphoric acid. Crucibles moulded from this mixture are said to be very resistant, and practically unaffected by molten alkali or strong acids. In another method starch serves as the binding agent, and the crucibles, after being dried at a low temperature for several days, are fired in a Hempel electric furnace at a temperature of 2,000 to 2,300 °C. Zirconia crucibles are now being manufactured in Germany.

Owing to its very low coefficient of expansion, ware made from zirconia can be plunged red-hot into water without risk of fracture. The suggestion has been made that zirconia could be used in ceramics, but for this purpose cheap zirconia free from iron would be required. Zirconia ware is said to be suitable for use as an electrical insulator up to temperatures of about 2,000° C.

It is stated that small quantities of zirconia are being used in the manufacture of a variety of silica ware known as "siloxide." The best results as regards resistance to devitrification were obtained by using about 0·5 per cent. of zirconia; but the best tensile strength was given when using about 1 per cent. of zirconia.

The use of clean zirconia as a pigment has been patented; it is stated to possess a pure white colour, and good covering power, and to be durable and non-poisonous. The silicate, basic carbonate, phosphate, and basic sulphite of zirconium have also been suggested as suitable for use as pigments.

Some years ago zirconia found a use as a component of the "glower" in the Nernst lamp, and was also tried, as a substitute for thoria, in incandescent gas mantles.

Zirconia is stated to be used, under the name "kontrastin," in place of bismuth salts for defining X-ray photographs of the intestines. Basic zirconium acetate has been patented as a weighting material for silk.

Ferro-zirconium, containing about 20 per cent. of zirconium, is made in the electric furnace, and employed to a small extent in the refining of steel, the quantity used being about 1 per cent. of the steel treated. Zirconium carbide was at one time used for incandescent electric-lamp filaments, but has been displaced by metallic filaments. It is also stated to be an excellent abrasive and to be suitable for cutting glass.

At the present time the demand for zirconia is met almost entirely by Brazilian baddeleyite, of which there is an ample supply. This mineral, as well as zircon, has also been found in Ceylon by the officers of the Mineral Survey working in that country in connection with the Imperial Institute (see *Colonial Reports, Miscellaneous Series*, No. 29 [Cd. 2341], 1905, p. 23; No. 37 [Cd. 3190], 1906, p. 21; No. 42 [Cd. 3762], 1907, p. 15; No. 74 [Cd. 5390], 1910, p. 6).

Ash of Cyperus Haspan.—An account of the ash of *Cyperus Haspan*, L., a reed grass found on the banks of certain rivers in the Ssongea district in German East Africa, is given in *Der Pflanzer* (1912, **8**, 678). The ash is noteworthy on account of the large percentage of potash it contains. "Salt" is prepared on a small scale for local use by the natives by treating the ash with water in a basket. The liquid which passes through is boiled down and the salt recovered. An analysis of this product gave the following percentage results, which are somewhat similar to those obtained at the Imperial Institute for a sample of "Kegr" salt from Northern Nigeria, prepared from the ash of *Salvadora persica* (see this BULLETIN, 1912, **10**, 304):

Potassium chloride . .	KCl	77·77	Silica	SiO_2	0·25
Potassium sulphate .	K_2SO_4	18·48	Water	H_2O	2·39
Ferric oxide and alumina	Fe_2O_3, Al_2O_3	0·23	Insoluble matter		0·35

Only traces of calcium, magnesium, and sodium salts were present; carbonates of the alkali metals were absent.

RECENT PROGRESS IN AGRICULTURE AND THE DEVELOPMENT OF NATURAL RESOURCES

In this section of the BULLETIN *a summary is given of the contents of the more important papers and reports published during the preceding quarter, in so far as these relate to tropical agriculture and the utilisation of the natural resources of the Colonies, India, and the Tropics generally.*

AGRICULTURE

SOILS

ANALYSES of 152 soils from Nag Hamadi, Egypt, are given in *Bull. de l'Inst. Égypt.* (1912, Ser. 5, **6**, 136). These soils, which were examined by the method described in the same journal with a view to ascertain their requirements for sugar-cane cultivation, were of three general types. These were, sandy soils from Safra, loams from Motawaseta, and clay soils from Zarga. The soils did not differ greatly in chemical composition, as is indicated in the following table:

	Soluble in concentrated nitric acid.		Soluble in 1% hydrochloric acid.	
	Top soil.	Subsoil.	Top soil.	Subsoil.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Potash. Safra	0·201	0·148	0·056	0·035
" Motawaseta . . .	0·179	0·144	0·058	0·038
" Zarga	0·209	0·178	0·058	0·038
Phosphoric acid. Safra . . .	0·171	0·150	0·065	0·054
" " Motawaseta .	0·153	0·147	0·056	0·050
" " Zarga . . .	0·160	0·156	0·058	0·051
Lime. Safra	2·00	2·00	—	—
" Motawaseta . . .	2·22	2·10	—	—
" Zarga	1·95	2·01	—	—
Nitrogen. Safra	0·052	0·035	—	—
" Motawaseta . . .	0·048	0·037	—	—
" Zarga	0·048	0·041	—	—

The composition of the subsoil in all cases shows that a good reserve of plant food is present. Certain soils, typical of the areas, were examined for alkali salts; those of Safra and Motawaseta contained on the average 0·08 and 0·07 per cent. respectively of sodium carbonate, together with 0·17 and 0·18 per cent. of sodium bicarbonate. The Zarga soils contained 0·19 per cent. of bicarbonate, but no carbonate. The application of dressings of calcium sulphate is recommended in order to neutralise the effects of these salts. The great influence of the physical condition of the soil on the crop is here illustrated by the fact that although these three types of soil are almost identical in plant food resources, the Safra lands yield two to five sacks of sugar per acre more than those of Motawaseta, which in turn have a similar advantage over the Zarga soils. The most important manure required by these soils is nitrogen, which is very essential for the growth of sugar-cane, and this is applied in the form of ammonium sulphate.

Comparative chemical and mechanical analyses of soils from German East Africa and South America are given in *Der Tropenpflanzer* (1912, **16**, 571). From the results obtained the author concludes that the soils of Tanga, Longusa, Ngambo, and Magunga, on certain of which Ceara rubber (*Manihot Glaziovii*) is being grown, are very similar to Bolivian soils from Acre, on which wild Para rubber (*Hevea brasiliensis*) is growing. The author concludes that, under proper climatic conditions, a soil suitable for rubber need not contain a high percentage of nitrogen, phosphoric acid, or humus, and that the trees require little lime or magnesia. A high content of lime in the soil probably has a deleterious influence on the flow of latex. A good percentage of potash in the soil is said to be most advantageous to the growth of rubber trees and the production of latex.

Soil Sickness.—The results of two investigations on the cause of soil sickness are given in the *Journ. Agric. Science* (1912, **5**, 27, 86). The first paper, by Messrs. Russell and Golding, deals with sewage sickness, which manifests itself by the retarded rate of percolation of the sewage and the impure state of the effluent. It was found that the application of screened sewage direct to crops of mangolds and cabbage, growing in the sick soil resulted in the death of the plants. Examination of the field showed that where the sewage had, for a time, failed to percolate, there was a greenish-black slime containing algæ, euglena, and numerous other living organisms. The deflocculation of the clay caused by the alkaline nature of the sewage had also assisted in preventing percolation. Both these factors, however, can be eliminated by ploughing the land and applying dressings of lime. Examination showed that the bacterial activity was less than might be expected, and little increase in the number of bacteria was caused by improving the physical condition of the soil. These facts pointed to the presence of some factor which tended to reduce the bacterial activity, and experiments showed that this could be overcome by partial sterilisation of the soil with antiseptics. When treated with carbon disulphide or toluene the number of bacteria rose from 20 to 30 millions up to 100 to 400 millions per gram of soil, and the rate of production of ammonia rose in a similar manner. The new bacteria, however, proved somewhat less vigorous than the old, but the soil no longer contained active amœbæ or other protozoa. These results indicate that the harmful effect is not due to plant toxins, but more probably to the presence of protozoa. Large-scale experiments, using 350 lb. of toluene or carbon disulphide per acre as a sterilising agent, gave satisfactory results, and when the practical difficulties of sterilising large quantities of soil have been overcome the method should be useful for sewage farms where slow decomposition is due to a deficiency of bacteria.

The sickness of glasshouse soils is the subject of the second paper, by Messrs. Russell and Petherbridge. It is well known that soils used for the intensive culture of cucumbers and tomatoes, although well manured, soon become sick and have to be replaced by fresh soil. In the case of cucumbers, this is often necessary after one season, but with tomatoes, where the culture is less intense, the soil often lasts five seasons. As these soils are highly manured, often being richer in plant nutriment than farmyard manure, considerable waste occurs by their being thus discarded. The sickness is often accompanied by insect and fungoid pests, one of which, *Heterodera radicicola*, produces the so-called "club" on the roots of both cucumbers and tomatoes. A consideration of other cases of soil sickness leads to the conclusion that it is associated with the high content of organic matter and water and the high temperature. The results of the authors' investigations show that the sickness is accompanied by a decreased bacterial efficiency due to the accumulation of some factor which is also present to a less degree in ordinary arable soils and can be put out of action by heat or antiseptics, and its properties are similar to those of protozoa. On a large scale the heat treatment (90-100° C.) can be carried out at a cost of about 1*s.* 6*d.* per ton of soil. The alternative treatment with antiseptics is much cheaper, and is said to promise greater possibilities of development, but the selection of a suitable agent is necessary: formaldehyde and certain tar oils appear to be suitable.

FOODSTUFFS

Wheat.—According to the *Rep. of the Minister of Agric., Canada*, 1911-12, p. 31, Marquis wheat, which has attracted attention in recent years on account of its early maturing, prolific bearing, and rust-resistant properties, produced good results during the past unfavourable season. This was especially the case in Saskatchewan, where it surpassed the old standard variety, Red Fife, in strength of straw, earliness, yield, and quality, on almost every farm where it was grown. At the Indian Head Experimental Farm it has given an average yield during five years of 50 per cent. more than Red Fife. It is stated to be the best variety for the greater part of Saskatchewan, for Central and Northern Manitoba, and for large areas in Alberta. The Dominion Cerealist is producing supplies of a very early ripening variety named "Prelude," which has shorter straw, and ripens two weeks before Marquis, producing red kernels of high weight per bushel. "Prelude" yields flour with good bread-making properties, though not equal in colour to Marquis or Red Fife. It is intended for those districts where Marquis cannot be depended upon to ripen before the frosts occur.

Sugar.—The *Int. Sugar Journ.* (1912, **14**, 571) contains some notes on the Mozambique sugar industry (see also this BULLETIN, p. 102). There are seven factories in the country, which produced 27,700 tons of sugar in 1911, whilst three other factories are stated to be in course of erection. The area devoted to sugar-cane cultivation is about 31,300 acres, and about 11,000 native labourers are employed on the estates. The production represents 2½ tons per labourer, as compared with 3 tons in Natal. The crop varies from 25 to 30 tons of cane, and from 2 to 5 tons of sugar per acre, as compared with 30 to 35 tons of cane and 3 tons of sugar per acre in Natal. Only 800 tons of the output in 1911 were retained for local use, whilst 6,000 tons were exported to Portugal, 5,000 tons to the Transvaal, and the remainder to Greenock.

In a paper contributed by F. W. South at the West Indian Agricultural Conference, 1912 (*W.I. Bulletin*, 1912, **12**, 365), the possibility of applying Mendelian principles to sugar-cane breeding is discussed. As the different characters of the sugar-cane exhibit but slight variations, and at present there is no analytical knowledge of those characters that will behave as Mendelian units, the writer considers the Mendelian method too uncertain to come within the sphere of work of a sugar-cane experiment station.

The results of experiments with seedling and other varieties of cane are recorded in *Rep. Agric. Work, Barbados*, 1909–11, p. 16. The behaviour of the selected canes and statistics of their produce on various soils are set out in detail. Hybridisation experiments are described, and it is stated that progress has been made in the work of crossing seedling varieties of known parentage.

The *Rep. Sugar Indust. of Australia*, dated January 1910, which has been issued recently (December 1912), deals chiefly with questions of labour, excise, and bounties. The attempt to replace coloured labour by white labour has met with considerable success in Queensland, the percentage of sugar produced by white and coloured labour in 1908 being 87·89 and 12·11 respectively, the corresponding figures for 1902 being 14·45 and 85·55.

Coffee.—Owing to the preference shown by planters in Nyasaland for cotton and tobacco, the area under coffee cultivation during the season 1911–12 was less by 1,000 acres than that of the previous year (*Ann. Rep. Dept. Agric., Nyasaland*, 1911–12). In consequence, however, of the abundant rainfall during the year, the exports showed a marked increase, amounting to 796,304 lb., valued locally at £16,381, being double the value of the last season's crop. The average price for Nyasaland coffee on the home market was 67*s.* to 84*s.* per cwt. It is anticipated that on account of the drought very little coffee will be exported from the crop now approaching harvest, and a larger reduction in acreage is expected next year.

Bull. Écon. de Madagascar (1912, **12**, 1) contains an article on the cultivation of coffee in the Province of Mananjary. The chief variety grown is Liberian, which was introduced about fourteen years ago, whilst Canephora coffee is grown to a smaller extent. The Province exported 92 tons of coffee in 1910, and 125 tons in 1911. The cultivation, diseases, and preparation of the crop for the market are described. Canephora coffee is stated to be resistant to *Hemileia vastatrix*. It is a smaller plant than the Liberian, and yields a crop in the third year. The yield of berry represents one-fifth of the fresh fruit, as compared with one-tenth in the case of Liberian, over which it possesses the further advantages of being more easily prepared and commanding a higher price. Canephora coffee, however, requires shade and a rich soil, and gives a smaller yield. In the case of Canephora the fruits all ripen at the same time, and thus require but one harvesting. This variety matures earlier than Liberian, and it is therefore possible to grow the two varieties side by side, and harvest the two crops with the same staff of labour.

Tea.—The area under tea cultivation in Nyasaland has risen from 1,190 acres in 1910–11 to 2,593 acres in the following year (*Ann. Rep. Dept. Agric., Nyasaland*, 1911–12). A keen demand was manifested during the year for land within the rain zone of South-East Mlanje, but owing to the restricted area with a suitable rainfall the development of the industry is limited.

The *Journ. Roy. Soc. Arts* (1912, **60**, 1064) contains a note on the tea industry of Java. In 1878 the cultivation of Assam tea was introduced into the Island, and has now entirely supplanted that of China tea. The output in 1900 was 6,600 tons, in 1905 11,228 tons, and in 1911 22,800 tons. The bulk of the crop is exported to Amsterdam and London, and in recent years large quantities have been shipped to Russia and Australia. *Der Tropenpflanzer* (1912, **16**, 439) describes the method of tea cultivation in Java, and contains statistics of production. The antipathy of the European planters towards the efforts of the Government to promote tea culture amongst the natives is discussed.

Cocoa.—According to information received from the Governor of the Gold Coast the cocoa crop of that Colony for 1912 was 86,197,151 lb., valued at £1,642,736. Although this represents a decrease of 3,285,075 lb. as compared with 1911, the quality of the cocoa has improved, the value showing an increase of £29,278.

Limes.—The statistics of the lime industry of Dominica (*Rep. Agric. Dept., Dominica*, 1911–12) show a decrease in the crop of 14,000 barrels of fruit as compared with that of 1910, which amounted to 369,000 barrels. The position of the industry is considered not unsatisfactory, as the crop of 1910 was much larger than that of 1909, and further, the total value of the exported limes and lime products during 1911 amounted to £73,882, an increase of £3,548 over that of the previous year. The export of green limes has grown from 15,799 barrels in 1906 to 36,520 barrels in 1911, whilst the export of citrate of lime for the same years is 733 cwt., value £1,503, and 5,926 cwt., value £19,259, respectively. In the report attention is drawn to the necessity of good drainage to prevent root disease. It is also stated that the success of the cultivation is in a large measure due to the prevalence of certain species of fungi which attack the various scale insects affecting citrus trees.

OILS AND OIL-SEEDS

Coconuts.—Cochin copra has always fetched very high prices, and according to Dupont (*Report on a Visit to India, etc.*, 1912, p. 46) this is due to the fact that the merchants who buy from the natives pick out all defective or dark coloured material and use this for preparing oil, only the selected copra being exported. The average rainfall is 115 in. and the mean temperature 82° F.

The "tapahan" method of drying copra is largely used in the Philippine Islands (*Philippine Agric. Rev.*, 1912, **5**, 617). In this method the copra is dried by means of fires composed of coconut husk and shell, and much of the copra is damaged by smoke owing to the use of damp husks.

There is a tendency now to use only shells which cause less smoke and damage, but the best method is to protect the copra from the smoke, which is produced after the fires are lighted, by means of sheet iron or by mats which can be removed when the fires have ceased to give off smoke and are burning brightly. In Laguna two steam drying plants have been started by a Filipino planter, and excellent copra is being produced; the apparatus used is a modification of a drier worked by the Bureau of Agriculture at the first Philippine Exhibition at Manila. The steam drier has also been found useful for drying copra which has been insufficiently dried by the "tapahan" process and has commenced to rot.

Information regarding many lesser-known insects attacking coconut palms is given in an article by Zacher in *Der Tropenpflanzer* (1912, **16**, 484).

The composition of coconut oil has been investigated by Elsdon (*Analyst*, 1913, **38**, 8), with results similar to those already obtained by other observers; the author is investigating palm kernel oil in the hope of finding a means of distinguishing this oil from coconut oil.

Linseed.—Trials with this crop in Rhodesia have been successful, and two varieties, viz. Pskoff and Yellow-seeded, which bear evenly ripening seed, have been obtained (*Rhodesia Agric. Journ.*, 1912, **10**, 15). This overcomes the difficulty experienced in previous trials with plants bearing seeds ripening over a long period; the Pskoff variety has also been found to mature several weeks earlier than other kinds. Rhodesian grown linseed has been favourably reported on in England, and farmers in Rhodesia are now recognising its value for feeding stock. The cost of exporting is high, but assuming an average crop of 3½ bags per acre, as was obtained in the trials, it is calculated that, after paying freight charges, £2 to £3 per acre should be obtained to cover cost of production and profit; this, it is stated, compares not unfavourably with the returns obtained from maize on most kinds of soil.

Oil Palm.—Attempts are being made to induce the natives to exploit the oil palms more thoroughly in the Duala district of Togoland; this question is fully discussed by Reder in an illustrated article in *Deutsches Kolonialblatt* (1912, **23**, 948).

A machine has been patented by Buchanan and Tyrell for removing the pericarp from palm and other fruits (U.K. Pat. 10,335, Feb. 9, 1911). It consists essentially of a stationary, elongated, horizontal cylinder, composed of triangular bars through which the palm fruits are fed by means of beaters mounted on a central shaft. The oily pericarp passes through the spaces between the triangular bars, whilst the nuts are carried to the end of the cylinder, and pass thence into a rotating wire cage, in which any pulp which remains on the nuts is removed. The central shaft may be hollow and so arranged that steam can be applied to the fruit inside the cylinder. The triangular bars are sharpened at the edges and are so mounted that they can be set at any suitable angle or turned so as to present a new edge when one becomes blunted.

An apparatus for the extraction of oil from palm or other fruit has been patented by Hawkins (U.K. Pat. 20,061, Sept. 9, 1912). In this apparatus the fruit is placed in a circular rotating pan or upon an endless travelling bed, above which is a framework bearing stationary, serrated baffles and pipes for the delivery of superheated steam or solvents, and also rollers for pressing down the mass of fruit in the pan. In operating this machine the fruits are fed into the circular pan, which is then caused to rotate. The fruits are thus brought into contact with the serrated baffles and with steam or solvents. The baffles, etc., are so mounted that they can be gradually lowered into the pan and thus disintegrate the pulp thoroughly. The outer wall of the pan is perforated, to allow the oil to flow into an outer collecting gutter.

Para Rubber Seeds.—It is reported that a factory has been established in Ceylon for decorticating Para rubber seed (*Trop. Agriculturist*, 1912, **39**, 251). £3 per ton is the price offered to rubber estates for seed.

Shea Nuts.—Experiments are being carried out at Koulikoro on the Niger with a view to ascertain (1) the average yield of shea nuts per tree, (2) the amount of fat in kernels taken from the same tree at different periods, (3) the amount of fat contained in kernels of different varieties (*Journ. d'Agric. Trop.*, 1912, **12**, 283). In 1911 twenty trees of varying size gave yields of dry nuts varying from 1¾ lb. to 85 lb. per tree. The amount of fat in the seeds taken from the tree when in full bearing was found to be 2 to 3 per cent. in excess of that in seeds gathered before or after this period. It was also found that the kernels of some varieties are richer in oil than others.

Shea trees are spread over the whole of the Sokode-Bessari district of Togoland, but are specially abundant on the steppes of Dagombaland. (*Mittl. aus den Deutschen Schutzgebieten*, 1912, **25**, 285). The residual kernel meal from which the shea butter has been prepared is used by the natives to smear on their mud huts to render them rainproof.

Sunflower Seed.—Since about 1845, sunflower seed has been grown on a large scale in Russia, where the seeds are used for food and as a source of oil and feeding cake (*Diplomatic and Consular Repts.*, *Ann. Series*, No. 4965

[Cd. 6005-138], 1912, p. 22). Fairly moist, well drained soil is most suitable, and plenty of rain is necessary during the growth and flowering of the plant, after which period dry, warm weather is needed until the harvesting of the seed. Yields of seed up to 18 cwt. per acre are obtained, but the usual yield is probably only about 7 to 8 cwt. per acre. The seeds are planted 2 to 3 ft. apart in both directions, or in rows 40 in. apart in which the plants are 20 in. apart. The leaves are generally allowed to remain on the stems, but lateral flowers are removed to encourage development of the terminal flower.

After harvesting, the seeds can be removed from the heads by shaking when the season is very dry or the seeds are over-ripe; otherwise the heads must be stacked or hung up to dry, the seeds being then removed by shaking, beating, or rubbing two heads together. Machines devised for removing the seed from the flower-heads do not appear to have been very successful, and the use of such machines has been largely abandoned, although wooden rasps or wire netting are sometimes employed. The use of appliances is unnecessary with those varieties of sunflowers having easily separable seed, and it seems advisable to recommend the selection and planting of these varieties. Good, dry sunflower seed is estimated to yield 18 to 24 per cent. of oil when the husks are removed before pressing, while 14 to 18 per cent. is obtained when unhusked seed is pressed. The proportion of husk to kernel varies in the different varieties of sunflower seed.

Beeswax.—Ghedda or East Indian wax has been found by Lipp and Kuhn (*Chem. Rev. ü. Fett. u. Harz. Ind.* 1912, **19**, 273) to differ from ordinary beeswax in containing the ester of ceryl alcohol alone, whilst beeswax also contains the ester of myricyl alcohol.

Miscellaneous.—The fruits of a species of *Trachylobium*, probably *T. Mossambicense*, Klotsche (= *T. Hornemannianum*, Hayne), belonging to the order Leguminosæ, which is one source of East African copal, have been found to contain 46 per cent. of oil in the kernels, which, however, constitute only 11·2 per cent. by weight of the fruits. The outer pulp comprises 41 per cent. by weight of the fruit, and contains 17·8 per cent. of oil (*Journ. d'Agric. Trop.* 1912, **12**, 233). The kernel oil is described as a semi-drying oil of golden yellow colour and unpleasant smell. The tree is said to occur frequently in the extra-tropical region of Mozambique, and to a less extent in the tropical region, but no information as to the possibility of obtaining commercial supplies of the seed is given.

In the *Agricultural Ledger*, No. 5 of 1911-12, Hooper deals briefly with the sources, characteristics, production, and uses of the oils and fats of India.

"Perah" seeds, derived from *Elateriospermum Tapos*, Miq., a large tree belonging to the Euphorbiaceæ, said to be common in Perak, Selangor, and Pahang, have been found by Barrowcliff (*Agric. Bull, F.M.S.*, 1912, **1**, 178) to contain 39 per cent. of light yellow liquid oil of pleasant taste, while the press cake was found to contain cyanogenetic glucosides. No information appears to be available as to the age at which the trees bear seed or as to the possibility of obtaining commercial supplies.

A trial shipment of forty tons of Munkuetti nuts (cf. this BULLETIN, 1911, **9**, 405) has been sent from German South-West Africa to Europe (*Board of Trade Journ.* 1912, **78**, 751). If the results of trials are favourable it is intended to erect an oil-extracting plant near Tsumeb. The nuts appear to be non-poisonous, as they are eaten by the natives. According to Grimme (*Chem. Rev. ü. Fett. u. Harz. Ind.* 1913, **20**, 1) the seeds consist of about 63 per cent. kernel and 37 per cent. shell. The kernels contain about 57 per cent. of drying oil, which should be suitable for paint, varnish, or soft soap manufacture.

Djave nuts (cf. this BULLETIN, 1908, **6**, 373; 1911, **9**, 157) have been examined by Wagner and Ostermann (*Chem. Rev. ü. Fett. u. Harz. Ind.* 1912, **19**, 249), who obtained results with the fat agreeing with those obtained by previous observers. They agree with Fickendey in stating that the seed residue after removal of the oil is not poisonous.

Holde and Meyerheim (*Chem. Rev. ü. Fett. u. Harz. Ind.* 1912, **19**, 302) have examined the oil of *Plukenetia conophora*, Muell. Arg. (Euphorbiaceæ), and have obtained analytical figures according fairly closely with those yielded by linseed oil; the oil also dries almost as rapidly as linseed oil (cf. this BULLETIN, 1912, **10**, 494).

"Galip" nuts from New Guinea have been found to consist of about 80 to 85 per cent. shell and 15 to 20 per cent. kernel, containing 65 to 71 per cent. of oil. The nuts are probably derived from *Canarium commune* (*Verh. Kolonial. Wirtsch. Kom.* 1912, No. 2, p. 74).

ESSENTIAL OILS

Turpentine Oil.—In the *Report on Forest Administration in the Western Circle of the United Provinces for* 1911–12 it is stated that, in the Naini Tal division, though fewer pine trees were tapped, the outturn of crude oleo-resin showed an increase of 1,725 maunds (1,263 cwt.) for the calendar year 1911, as compared with 1910. The new method of tapping, introduced in 1910–11, using a channel of curved cross-section, has proved so satisfactory that in future it will be generally adopted. A new steam distillation plant has been purchased and erected at the Bhowali distillery, and trials show that good results may be expected in the cost of working and in the yield and quality of the products. The amount of oleo-resin collected in this district during the year ending July 1912 was 19,669 maunds (14,460 cwt.), yielding 26,739 gallons of turpentine oil and 11,826 maunds (8,658 cwt.) of rosin.

In Kumaun the prospects of the industry are promising. Tapping operations are being largely extended, and a yield of 30,000 maunds (22,000 cwt.) of oleo-resin is expected for the year 1912.

In the Chakatra division also satisfactory results have been obtained; though fewer trees were tapped than in the preceding year, there was a higher yield of oleo-resin.

Star Anise Oil.—In an article entitled "La Badiane au Tonkin," by M. Philippe Eberhardt in *Annales de la Drogue et de ses dérivés* (1912, **10**, No. 22, p. 28), a detailed account is given of the present state of the star-anise industry in Tonkin. Until recently little has been done in the systematic cultivation of *Illicium verum*, which yields this oil. Formerly, the natives sowed the seeds round their dwellings and gave the plants little or no attention other than harvesting the fruits. They now recognise the advantage of rearing the young plants in nurseries and subsequently transplanting them. The young plants are shielded from the heat of the sun, to which they are very sensitive, by training Cucurbitaceæ over a bamboo framework erected above them. For satisfactory growth they require a deep soil, rich in humus. Considerable losses are suffered through the neglect of the natives, who do not water the plants after transplanting them. The distance which should be left between the plants to ensure satisfactory development is eight metres, but they are often planted with an intervening space of only five metres, or even less. The distillation of the fruits, which is described in full, is carried out in earthenware stills of Chinese origin. M. Eberhardt suggests that the leaves also of the plant should be distilled. The leaf oil has rather a low congealing point (13°–14° C.), but he thinks it could be mixed judiciously with the oil from the fruits, which often has a congealing point of 17°–18° C., to bring the congealing point to the commercial standard of 16° C. Consumers of this oil in Europe are not likely to view this suggestion with favour.

Australian "Sassafras" Oil.—An investigation of the oil of the leaves of *Atherosperma moschata*, Labill., the "Australian sassafras," natural order Monimiaceæ, is published in the *Journ. Chem. Soc.* (1912, **101**, 1612). The main constituent of the oil is eugenol methyl ether, which is present to the extent of 50 to 60 per cent.; 15 to 20 per cent. of pinene and of *d*-camphor, and 5 to 10 per cent. of safrole, are present. The tree, which is quite distinct from *Sassafras* *officinale*, is stated to grow luxuriantly in the mountain gullies around Healesville and Warburton in Victoria.

RUBBER

The production of rubber in North Madagascar is the subject of an article by H. Hamet and L. Josse in *l'Agric. prat. des Pays chaud* (1912, **12**, 265). The chief rubber-producing plants are the following (compare this BULLETIN, 1911, **9**, 162): *Landolphia madagascarensis*, which yields a latex coagulable in the cold by 5 per cent. sulphuric, citric, and other acids, and by common salt on heating. The rubber is pinkish, and rapidly darkens in the air. The yield varies from 6 to 25 per cent. of the latex, according to the season, the age of the plant, and part of the plant from which the latex is obtained. The commercial value of the rubber is 60 per cent. of that of Para. *L. Perrieri* yields an abundant latex, which is coagulable by the same means as above. The rubber is of excellent quality, but the yield is poor. *L. sphærocarpa* yields abundant latex, containing 18 to 26 per cent. of rubber of excellent quality. *L. tenuis* also yields a rubber of good quality. *Cryptostegia madagascarensis* yields an easily coagulable latex, containing 15 to 20 per cent. of rubber, but the adult branches only should be tapped. *Marsdenia verrucosa* yields abundant latex, containing 10 to 12 per cent. of rubber, of very poor quality. *Mascarenhasia anceps*, *M. longifolia*, and *M. utilis* yield the "black rubber" of Madagascar, the commercial value of which is 50 to 60 per cent. of that of Para. The authors describe the habits and distribution of the above species in the north of Madagascar, and the methods employed for preparing the rubber, and suggestions are made for improving the quality of Madagascar rubber.

The same *Journal* (1912, **12**, 425) contains a description by H. Jumelle and H. Perrier de la Bathie of the *Mascarenhasia* spp. of East Madagascar.

Der Pflanzer (1912, **8**, 433) contains a detailed account, by E. Marckwald and F. Frank, of an examination of samples of Ceara rubber from East Africa. They examined forty-one samples which had been prepared with different reagents, either by coagulation on the tree or by coagulating the collected latex. Amongst the reagents used in the two sets of experiments were 1 to 2 per cent. solution of calcium chloride, purub, or lactic acid, 5 per cent. citric acid solution containing 1 per cent. of calcium phosphate, acetic acid containing 0·5 per cent. of phenol, 10 per cent. citric acid solution containing 5 per cent. of calcium phosphate, and lastly boiling water.

The viscosities of solutions of the raw rubbers were determined, and the samples were also vulcanised and tested for elasticity and strength by means of the Schopper apparatus. The quality of the corresponding samples furnished by the two methods did not agree in most cases.

The authors remark that working of the rubber, such as creping on the plantations in East Africa, is not attended with good results. It was found that rubber coagulated by means of calcium chloride cannot be afterwards washed free from chlorine. The juice of the wild lemon, where obtainable, is regarded as the best means of coagulating the rubber on the tree, and citric acid solution containing magnesium salts or calcium phosphate as the best means of preparing rubber from collected latex.

Hevea brasiliensis.—*The Report Agric. Dept., Gold Coast*, 1911 (p. 8), contains an account of experiments on the cultivation of Para rubber at the Aburi and Tarquah agricultural stations.

A table is given showing monthly yields from tapping experiments at Aburi. It was found that considerable diminution of yield follows continuous tapping for 18 months, but that the dry season or wintering of the trees does not materially affect the yield. An average yield per tree of 2 lb. 1·9 oz. of dry rubber was obtained for the whole year with 152 tappings. Yields from renewed bark give indications of being greater than those from the original bark. At Tarquah better results were obtained. Thirty trees planted 15 × 15 ft. apart gave an average yield of 3⅓ lb. dry rubber per tree for the whole year. One thousand trees, however, planted 12 × 12 ft. apart, gave an average of only 1½ lb. dry rubber per tree for 10 months' tapping. This was thought to be due probably to too shallow tapping. The rubber obtained in the experiments was sold at 4*s*. 9¾*d*. per lb., with fine hard Para at 4*s*. 8*d*. per lb. and plantation Para at 5*s*. per lb. The cost of production of Para rubber in the Gold Coast is estimated at considerably below 2*s*. per lb. *Hevea brasiliensis* also shows satisfactory growth at Coomassie and Assuantsi, where many trees are nearly ready for tapping.

"The Nitrogenous Constituent of Para Rubber" is the title of a paper by C. Beadle and H. P. Stevens in the *Journ. Soc. Chem. Indust.* (1912, **31**, 1099). Sheet rubber was allowed to swell in benzene and the solution separated by decantation from the undissolved portion, and the benzene evaporated from each. The solution gave a rubber of pale golden colour, containing practically no nitrogen; the insoluble portion gave a darker coloured product, rich in nitrogen. The samples of rubber thus obtained were vulcanised under the same conditions as (1) a sample of the original rubber and (2) a sample which had been obtained by allowing the original rubber to swell in benzene and evaporating off the benzene. The vulcanised rubbers were tested by the Schwartz machine.

It was found that the amount of "combined sulphur" and degree of vulcanisation effect was dependent on the proportion of insoluble matter as measured by the percentage of nitrogen in the rubber, *i.e.* the combined sulphur was highest when the nitrogen content was lowest. The mere swelling of the rubber in the solvent, with subsequent removal of solvent by evaporation, was without effect on the quality of the rubber. The vulcanised product from the nitrogen-free rubber was much more distensible than that from the other samples, but its tensile strength and other physical properties were decidedly inferior. The conclusion is drawn that synthetic rubber, being free from insoluble nitrogenous matter, would be inferior to the natural product. The authors state that the removal of "resin" also results in a deterioration of the quality of rubber.

Funtumia elastica.—The *Report Agric. Dept. Gold Coast*, 1911, p. 10, gives the results of experiments on the tapping of *Funtumia elastica* at Aburi, designed to test (1) the best time to tap, (2) the comparative yields from trees of different girths, (3) the average yields per tree at the first and subsequent tappings. The vertical parallel system of tapping was adopted as being the most easily adapted to the experiments. The results are tabulated, and indicate that the period June to December or January is the best time to tap. Tapping at intervals of two months gave a total yield of rubber almost as large as tapping at four or six months' interval. The largest trees gave the largest yields of rubber. The average yields per tree at the first and subsequent tappings, at 2 months' intervals, were:

	Latex. *C. cm.*	Dry rubber. *Grams.*
1st tapping (October)	37·2	17·7
2nd ,, (December)	28·1	11·7
3rd ,, (February)	15·5	8·5

Although the incision method of tapping was employed, the wounds did not heal up well, and it is still uncertain how soon re-tapping can be profitably commenced. The yields from Funtumia in the Gold Coast are poor and compare unfavourably with those from Hevea. However, it is easily cultivated and can be grown in semi-dry regions where Hevea does not thrive.

Oxidation of Rubber.—The action of gaseous oxygen on indiarubber has been studied by S. J. Peachey (*Journ. Soc. Chem. Indust.* 1912, **31**, 1103). A thin film of purified rubber of known weight was deposited from pure benzene solution on the interior surface of a flask which was connected with a measuring apparatus, and the whole filled with oxygen. The flask was immersed in water, and maintained at a temperature of 85° C. until absorption of oxygen ceased.

It was found that the volume of oxygen absorbed corresponded to four atoms of oxygen for every $C_{10}H_{16}$ complex. This result is contrasted with that of Herbst (*Ber. d. d. chem. Gesell.* 1906, **39**, 523), who found that on passing air for a prolonged period through a heated benzene solution each $C_{10}H_{16}$ complex absorbed one atom of oxygen (cf. also this BULLETIN, 1912, **10**, 675). The presence of "resin" (3 per cent.) in the rubber exercised very little influence on the total volume of oxygen absorbed, but greatly retarded the rate of oxidation.

FIBRES

A recent supplement to *Der Tropenpflanzer* (*Beihefte*, Nos. 5–6, 1912) is devoted to a full and well-illustrated account, by Dr. W. F. Bruck, of the cultivation and preparation of fibres in the Dutch East Indies and the Philippines. The work consists to a large extent of original observations made by the author during a visit to these countries in 1911. The products dealt with in connection with the Dutch East Indies are Manila hemp, kapok, Java jute (*Hibiscus cannabinus*), and the fibres of *Agave* spp. (cf. this BULLETIN, 1912, **10**, 301). The Philippine fibres include Manila hemp, "Maguey" (*Agave Cantula*, Roxb.) and pineapple fibre.

African Wild Silk.—Reference to the wild silks of Africa has been made previously in this BULLETIN (1907, **5**, 438; 1910, **8**, 150; 1911, **9**, 412). There are three kinds of silkworm occurring in the wild state in Uganda, viz. *Anaphe infracta*, Walsm., *Hypsoides milleti*, de Juan, both belonging to the Eupteridæ, and *Mimopacha gerstackeri*, Dew., of the Lasiocampidæ. The first of these is the most common, although not particularly abundant, whilst the last is comparatively rare. In the *Ann. Rep. Dept. Agric., Uganda Protectorate*, for 1910–11, an account is given of some experiments carried out on the domestication of *Anaphe infracta*, and the life-history and habits of the insect are described. The plants on which the insect feeds are *Bridelia micrantha*, *Cynometra Alexandri*, and *Triumfetta macrophylla*. The experiments were made with *Bridelia micrantha*; the trees should be planted 6 ft. apart, and when they are large enough to support a colony of silkworms, the larvæ may be introduced either by tying a cocoon-mass on the tree, or by placing the eggs on the leaves.

Paper-making Materials.—Attention has been drawn recently to the possibility of utilising *Hedychium coronarium*, of the natural order Zingiberaceæ, for paper-making (*Kew Bulletin*, 1912, No. 9, 373). This plant is indigenous to India, and also occurs in Central America, the West Indies, New Zealand, and West Africa. It has been introduced into Brazil, and is now abundant in the wild state in many parts of the country, and especially at Morrettes in the State of

Parana. The plant spreads rapidly by means of creeping rhizomes, from which spring numerous leafy stems. The stems have been investigated by Messrs. Clayton Beadle and Henry P. Stevens, who have reported that they yield a useful fibre, and can be converted into paper which is very strong and exceptionally elastic (*Reports of the Eighth International Congress of Applied Chemistry*, 1912, **13**, 39). If the cells are allowed to remain in the pulp with the fibres, the paper produced is very strong and of a parchment-like character; but if the cells are removed, the paper is of a soft nature and medium strength. The yield of pulp containing both cells and fibres is about 60 per cent. of the weight of the air-dry stems, whilst that containing fibres only is about 50 per cent. The fibres have an average length of about 0·1 in.

Reference is also made in the *Kew Bulletin* (1912, No. 9, 377, 396) to three other plants which have been examined by Messrs. Clayton Beadle and Stevens. The stems of *Amomum hemisphericum* and *Alpinia nutans*, both plants of the natural order Zingiberaceæ, yield 58·2 per cent. and 50·0 per cent. of fibre respectively (calculated on the dry stems). In each case the fibre would be quite serviceable for paper-making, although inferior to that of *Hedychium coronarium*. The third plant is Marram grass, which is commonly grown on the sand-hills of the coasts of the United Kingdom, and could be readily cultivated on extensive tracts. The dry grass yields 31·4 per cent. of unbleached pulp, which somewhat resembles that obtained from esparto grass.

Cotton

Egypt.—According to the *Monthly Return of the Egyptian Cotton Crop* (1912, No. 1), the area under cultivation (as registered by the returns of the Direct Taxes Department) amounted in 1911 to 1,711,241 feddans, and in 1912 to 1,721,815 feddans (1 feddan = 1·038 acres). The varieties grown and the percentage of the total area occupied by each were as follows: In 1911: Mitafifi, 49·4; Yannovitch, 14·7; Nubari, 6·8; Sakellaridis, 7·0; Abassi, 1·9; Ashmouni, 19·3; Voltos and other varieties, 0·9. In 1912: Mitafifi, 40·2, Assil, 2·3; Yannovitch, 13·9; Nubari, 9·2; Sakellaridis, 11·5; Abassi, 2·1; Ashmouni, 20·0; Voltos and other varieties, 0·8.

The cotton crop of 1911–12 was superior to that of 1910–11 in quantity, but was inferior in quality, owing to excessive heat and a deficiency of water at the critical period of growth, and to subsequent overwatering at the time of the floods. The Mitafifi cotton shows a continuous decline in colour, quality, and yield, and the seed is impure. Extra fine qualities are scarce, the proportion of "dead" (immature) cotton increases, and the crop is often mixed with Nubari.

The Assil variety (this BULLETIN, 1911, **9**, 409) has not altogether fulfilled the expectation that it would replace Mitafifi; it appears to be related to Nubari rather than to Mitafifi. The Yannovitch cotton has deteriorated, and the seed has become impure. The Nubari variety has undergone a striking deterioration in quality, and very little of the extra fine grade is produced. The Sakellaridis cotton (this BULLETIN, 1911, **9**, 288) is the best now grown in Egypt, and in good districts has maintained its quality. The Abassi variety has deteriorated to some extent, and is being largely replaced by Voltos cotton. The latter variety gives good yields; it resembles Abassi, but is stronger and of a more creamy colour.

Northern Nigeria.—It has been stated previously (this BULLETIN, 1912, **10**, 480) that since the completion of the Baro-Kano Railway the exports of cotton from Northern Nigeria have shown a striking increase. The total quantity purchased by the British Cotton Growing Association in 1912 amounted to about 2,500 bales, of 400 lb. each, a great advance on any previous year.

During October and November 1912 one of the Association's officers made three tours in the Zaria Province, and encouraged the farmers to extend the area devoted to the crop. He was greatly impressed with the prospects of cotton-growing in some of the districts through which he passed, and was led to the conclusion that the output of the Zaria ginnery in 1913 will approximate to 7,000 bales as against 2,135 bales in 1912.

Mauritius.—Experiments in cotton-growing have been carried out in Mauritius, and have afforded valuable information, although they have not led to definite conclusions (cf. this BULLETIN, 1912, **10**, 501). An account of the more recent work is given in the *Rapport Annuel pour* 1911, *Station Agronomique, Mauritius*. Serious losses were occasioned by cyclones, which are of common occurrence in the island, and it is considered that a season wholly favourable to cotton would be quite exceptional. Nevertheless, it is thought that the cultivation might be possible under certain conditions; but, unfortunately, it is difficult to procure the necessary labour, on account of the more profitable employment afforded by the sugar plantations.

India.—A study of the seed supply of certain districts of the Bombay Presidency has shown that the cotton seed used by the ordinary cultivators is very inferior (cf. this BULLETIN, 1911, **9**, 410). In this connection, an account of "A Method of Improving the Quality of Cotton Seed" has now been published as *Bull. No.* 53, 1912, *Dept. Agric., Bombay*. It has been found that the germinating power of the seed can be enhanced by separating the heavy seeds from those which are light and damaged. This may be effected by the method devised in the United States, and described in this BULLETIN (1908, **6**, 74).

Tunis.—Efforts are being made in Tunis, under the auspices of the French Colonial Cotton Association, to ensure the purity of the seed employed for sowing in order that the crop may be of a homogeneous character, and therefore of greater value (*Journ. d'Agric. Trop.* 1912, **12**, 378). The Administration have decided to adopt a measure compelling planters to uproot, or permit to be uprooted, any plants in the field which do not conform to the type of the variety under cultivation; by this means hybridisation will be prevented. In certain cases the planters will receive compensation. The Administration reserves to itself the right of purchasing the seed. This system has met with the approval of nearly all the planters.

German East Africa.—During the year 1912 considerable apprehension was aroused in Mwansa, German East Africa, by the occurrence of a peculiar disease affecting the leaves of the cotton plants. The disease was first recognised by the appearance of a shiny incrustation on the upper surface of the leaves; in some instances tiny drops of similar material were noticed on the hairs on the lower surface. This affection, termed the "Mafuta" disease, has been studied by Dr. Kränzlin, and an account of his work has been published in *Der Pflanzer* (1912, **8**, 640). It has been proved that the incrustation is not formed by the leaves themselves, but consists of the excrement of a certain insect. The extent to which the plants are injured by the disease has not yet been established, but probably it is not very serious. In order to check the spread of the insects, it is suggested that the first plants which are attacked should be destroyed. The best remedy, however, is to ensure that the plants are grown under such conditions that they can undergo strong and healthy development, since it has been found that they are then more resistant to the insects, and the latter are not able to multiply greatly.

TOBACCO

The manurial experiments with tobacco conducted during the year 1910–11 in Java, are described in detail in *Mededeelingen van het Proefstation voor Tabak*, No. V. The chief problem was to ascertain in which of the three principal nutrients—nitrogen, potash, and phosphoric acid—the soil was most deficient. In interpreting results the improvement in quality and colour of the leaf as well as the yield was considered. The application of artificial manures, containing varying amounts of the three constituents just mentioned, showed that the least increase in yield over unmatured ground was obtained when nitrogen was omitted from the manure, and that a mixture of nitrogen and potash was the most beneficial.

The manure employed consisted of 3 grams sulphate of ammonia, 1½ grams superphosphate, and 1½ grams sulphate of potash per plant; but it was found that the application of twice this quantity not only doubled the increase in yield in many cases, but also effected a great improvement in the colour and quality of the tobacco. Further experiments, to ascertain the largest amount which it is profitable to apply, are being proceeded with.

Trials to compare a mixed manure, sold under the name of "tobacco guano," with a prepared manure of the same potash, nitrogen, and phosphoric acid content, showed that practically the same increase was obtained in each case; but the cost of the prepared manure was only slightly more than half that of the "guano." Comparative trials of the value of nitrogen as an ammonium salt and as a nitrate are in progress. These experiments, and others with native manures (bat guano and night soil), are not yet sufficiently advanced to justify conclusions being drawn.

According to the *Ann. Rep. Dept. Agric. Nyasaland*, 1911–12, the tobacco crop amounted to over 2,000,000 lb., equivalent to 2 per cent. of the tobacco consumed in the United Kingdom during 1911. This source of supply is attracting considerable attention, but some difficulty has been experienced in persuading manufacturers to use Nyasaland tobacco in place of "Virginian" leaf, although the former may be equal in quality. Attention is drawn to the damaged condition in which large bales arrive from Nyasaland. The tobacco in small bales, 2 ft. 6 in. by 2 ft. 6 in. by 2 ft., compared favourably with that from the United States, which is packed in hogsheads.

The annual tobacco crop of Madagascar, exclusively a native cultivation, is estimated at about 800 tons (*l'Agric. prat. des Pays chauds*, 1912, **12**, 192). It consists entirely of indigenous varieties, chiefly hybrids, of which the principal one, known as "Jilo," has short, straight, pointed leaves. The total crop is consumed locally, and about 15,000 lb. is imported from Réunion, Algeria, France, Natal, and Egypt. Methods of cultivation and particulars of the local markets are given.

Information on the growing and preparation of "bright" tobacco under local conditions is given in an article in the *Rhodesia Agric. Journ.* (1912, **9**, 675). It is stated a sandy soil is the most suitable, usually derived either from granite or sandstone, and in the opinion of the author, the poorer the soil, the brighter the leaf produced. The results on heavy, rich soil have been disappointing, and the product only saleable at unremunerative prices. Particulars for the production of a continuous supply of seedlings are given. Details of transplanting and treatment in the field follow, together with a description of harvesting and preparation. These points are dealt with in an article in this BULLETIN (1910, **8**, 172). The author considers that it is not advisable to grow tobacco more than three consecutive seasons on the same land, as the colour of the leaf darkens each year under such conditions.

Bulletin No. 241, 1912, *Bur. Plant Ind., U.S. Dept. Agric.* deals with the use of artificial heat in the curing of cigar-leaf tobacco. It is stated that the application of artificial heat under proper conditions does not injure the quality of cigar tobacco, but, on the contrary, insures better curing, especially as regards the colour of wrapper-leaf tobaccos. Open charcoal fires are used extensively in the Connecticut Valley in curing shade-grown tobaccos, but the fuel is expensive, and the management of the large number of small fires required for the purpose needs much time and care. A method of heating by means of flues and a system of ventilation are described. The details of construction of the plant employed are given, and it is stated that excellent results have been obtained. By the use of artificial heat the planter is no longer dependent on climatic conditions, but can adjust the heating and ventilation to obtain the desired effect.

FORESTRY

Tasmanian Forests.—The Report for the year ending June 30, 1911, by the chief forest officer of the Forest Branch of the Department of Lands and Surveys, Tasmania, states that the total amount of revenue received by the Department from all sources under this head for 1910–11 was £4,366, or £526 in excess of the amount for 1909–10. The timber exported during 1910 amounted to 9,547,976 superficial feet, of value £47,136, and the production during the same period was 54,483,198 superficial feet of sawn timber, valued at £193,081. The greater portion of the timber produced in Tasmania is shipped to various parts of the Commonwealth. A consignment of iron-bark sleepers, comprising 1¼ millions of superficial feet of timber, was forwarded to Bombay, the greater part of the timber being obtained from the sea coast. The manufacture of furniture from Tasmanian hardwoods is making rapid advancement. The timbers used for this purpose are stringy-bark and another eucalypt commonly known in the trade as "Tasmanian Oak." The total area of land held from the Crown for the purpose of obtaining timber on payment of royalty is 110,772 acres.

Forests of the Ivory Coast.—In *l'Agric. prat. des Pays chauds* (1912, **12**, 334) are given the regulations, laid down by the French Government in June 1912, for the exploitation of the Ivory Coast forests. The regulations, which are sixty in number, deal with the conditions and methods of working both the Government and privately-owned woods and forests, the rights and privileges of the natives in the Government forests, the suppression of offences, and with the disposal of timber felled or products collected contrary to these regulations.

Teak (*Tectona grandis*).—In the German colony of Togoland teak has been planted at all the forestry stations. According to a *Report on the Afforestation of Togo*, 1912, by A. H. Unwin, the total area under teak is about 900 acres. The situation of the plantations varies from 50 to 1,800 ft. above sea-level, and the trees are found to thrive in almost any kind of soil, with the exception of swampy areas and very poor sandy soil over an iron-stone pan. The trees for planting about half the area were raised in nurseries, the others from seed planted *in situ*; the former have given the better results. From their first to their fifth year the trees grow rapidly, but after this period their growth in height slackens. Small crops of seed are produced in the third and fourth years after planting, and good crops in the fifth and following years. Some of the areas under teak are pure plantations, others are mixed. The species used for growing in association with teak are ebony (*Diospyros mespiliformis*), West African rubber (*Funtumia elastica*), iroko (*Chlorophora excelsa*), African mahogany (*Khaya senegalensis*, and the allied species, *K. Klainii*), and sasswood (*Erythrophlœum guineense*). The object of planting other trees is to protect the soil during the period when the teak trees shed their leaves.

The Togoland plantations are to be treated as "high forest," and are to be worked under a rotation period which has been provisionally fixed at eighty years. The estimated average cost of the plantations in their second year is £3 per acre.

In Deli, on the east coast of Sumatra, teak is employed in the construction of drying-sheds for tobacco. An account of these structures and the utilisation of teak in this connection is given in *Journ. d'Agric. Trop.* (1912, **12**, 268). The teak piles are obtained from young trees ten to fifteen years old, grown from seed, and the rafters from which the tobacco is suspended from trees five to six years old. The piles are from 30 to 36 ft. in length, and have a diameter at the base of from 8 to 12 in., or sometimes even 14 in. After being cut down to the ground the young teak trees reproduce themselves very quickly, and in from three to four years the coppice shoots are sufficiently large to be of use in the construction of drying-sheds, especially if care be taken to remove the bark, which is very thick and useless. Other kinds of timber which are similarly employed in Sumatra are furnished by species of mangroves which occur in salt soils near the sea, and by *Casuarina equisetifolia*, a quick-growing tree which is planted by the road-sides in Deli for shade.

The growing scarcity of teak, and the consequent rise in price of this important timber, necessitates finding substitutes. In the notice of a paper by Mr. E. V. de Coque (*Trop. Agric.* 1912, **39**, 161) the following timbers, which occur in the Dutch East Indies, are recommended as teak substitutes: Tempenis (*Sloetia sideroxylon*), balau (*Parinarium oblongifolium*), and a species known locally as "ironwood." Tempenis and balau also occur in the Malay Peninsula, and specimens of these timbers may be seen in the British Malaya Court of the Public Exhibition Galleries of the Imperial Institute.

African Mahoganies.—In his *Report on the Afforestation of Togo*, 1912, Unwin refers to experimental plantings of two species of Khaya and of the Rhodesian "mahogany" (*Afzelia africana*). The plantations have been formed by transplanting or by planting at stake, and are to be grown as high forest with a rotation of eighty years. The largest area is occupied with *Khaya senegalensis*, over 2,000 acres in different parts of the country having been planted with this species. The tree has been found to grow somewhat slowly and to be very susceptible to the effects of stagnant water or bad drainage, becoming under such circumstances stag-headed and more liable to borer attack. A light, well-drained soil appears to be most favourable to the tree. This species is found to grow best in mixture with other trees, sasswood (*Erythrophlœum guineense*) and teak being tried with success.

Eighty-four acres have been planted up with *Khaya Klainii*, the timber of which is very similar to that of *K. Punchii* and *K. grandis*. The growth of this tree is considerably faster than that of *K. senegalensis*, but it would seem to be the most exacting of the mahoganies with regard to soil fertility. Practically the whole area planted is in mixture with teak and sasswood. Rhodesian mahogany is found in the dry zone and deciduous forest of Togo. It has been used for bridge and house building in the German colony, and in Southern Nigeria the Public Works Department has successfully employed this wood. The total area planted is 174 acres, carrying a mixture of Afzelia, iroko (*Chlorophora excelsa*) and sasswood, or other species. The tree does not appear to be exacting as to soil conditions, but it is of slow growth, and of "stumpy" habit when young, six-year-old plants being only 32 in. high, with a girth of 18 in.

Iroko or Odoum.—The German plantations of this tree

(*Chlorophora excelsa*) in Togo are described by Unwin in the report referred to above. The best results have been obtained from seeds sown at stake, and it would appear that the plant is exacting as to soil and intolerant of shade. The growth is good, a height of 24 ft. with a girth of 28 in. being reached in three years. Both pure and mixed plantations have been made, but a mixture of teak with iroko is better than the iroko alone. The plantations are to be grown as high forest, with a rotation of eighty years.

Sasswood.—This wood (*Erythrophlæum guineense*) has been largely used in Togo for bridge construction, for which purpose it has been found to be very durable, and immune from attacks of white ants; it is also said to be without an equal for pile-work. The German plantations of this species are referred to by Unwin in the report already mentioned. Over 580 acres have been planted, chiefly at Haho-Baloe, and mostly on poor soil. Sowing at stake has been more successful than transplanting, though somewhat slower growth results, the average being 2 ft. in the first year, but with a faster rate in subsequent years. Mixed plantations have been found to be preferable to pure growths, and teak and mahogany have been used for this purpose.

TANNING MATERIALS

Divi-divi.—According to the annual report of the work done during 1911–12 at the Experimental Gardens at Amani, German East Africa, divi-divi (*Cæsalpinia coriaria*) trees planted at the end of 1908 have in some cases blossomed and borne a few fruits, which have not ripened (*Der Pflanzer*, 1912, **8**, 530). The trees, on the whole, are considered to have developed well. The trees at Rabaoul Gardens are doing well, but the younger ones have suffered from the effects of drought (*Deut. Kolonialblatt*, 1912, **23**, 92). A sample of pods from this station has been reported on as satisfactory by the Leather Institute at Freiberg.

Mangrove.—In Portuguese East Africa both white and red mangrove trees exist in great quantities along the shores of the bays and inlets. The red variety has been exploited for several years, and is shipped to the United States, where there is an extensive and growing market for this tanning material (*Ind. Tr. Journ.* 1912, **28**, 122).

Prior to 1908 the district of Lourenço Marques was the centre of this industry, but in that year an order was put into effect which prohibited the collection of mangrove bark for industrial purposes for a period of ten years. As a consequence, the territory of the Mozambique Company has now become the centre of the industry. The extent of the forests here is unknown, but in 1910 bark was exported to the value of £19,000. The bark is stripped from the trees and collected into piles on the shore by the natives at a daily wage of 5*d.* to 1*s.*, and is ultimately shipped by coasting vessels to the large sea-ports.

The Philippine Islands also contain vast forests of mangroves, 500,000 acres in extent. The commonest varieties found are *Rhizophora mucronata* and *R. conjugata*, the barks of which contain 28 per cent. of tannin and *Bruguiera gymnorrhiza* and *B. eriopetala*, both with 32 per cent. of tannin in their barks. These barks could be used for the manufacture of extract, which would find a market in the United States, where it would probably compete successfully with that from Borneo, since it would be admitted duty free (*Bull. Écon. Indo-Chine*, 1912, **15**, 770).

In Malaya at the present time only a small quantity of mangrove bark is used for tanning purposes, and that chiefly by the Chinese (*Agric. Bull. F.M.S.*, 1912, **1**, 177). The barks of *Ceriops candolleana*, *Rhizophora mucronata*, and *R. conjugata*, were found to contain 42·6 per cent., 29·1 per cent., and 10·4 per cent. of tannin respectively, and there appears no reason why these materials should not be profitably used for the manufacture of tanning extract, as is done in Borneo, especially as large quantities of bark are obtained as a by-product of the firewood industry.

ECONOMIC MINERALS

Alunite.—"Alunite," by B. S. Butler and H. S. Gale (*Bulletin* No. 511, 1912, *U.S. Geol. Surv.*), gives an account of a newly-discovered deposit of alunite near Marysvale, Utah, which is now being developed, and promises to become a source of potash. Alunite closely resembles potash alum in its chemical composition, but contains a relatively larger proportion of alumina. It is insoluble, but is readily converted into either the soluble potash alum or potassium sulphate. The Marysvale alunite contains about 10 per cent. of potash (K_2O).

The deposit occurs in a large banded vein cutting through the andesites (volcanic rocks) which form the greater part of the Tushar Range. These volcanic rocks are post-Jurassic in age, and are probably Tertiary. On each side of the main vein smaller bands of alunite alternate with bands of silicified wall-rock. In one place the main vein is 20 ft. thick. The outcrop has been proved over a length of 3,500 ft., and assuming an average width of 10 ft., it is estimated that there will be at least 300,000 short tons of the rock for each 100 ft. of depth, so long as the deposit maintains its surface dimensions and quality.

An examination of the mineral veins of the district shows that they are for the most part fissure veins of the quartz-carbonate type. Many of them contain notable amounts of adularia (a potash felspar), together with smaller amounts of other minerals, including fluorite and metallic sulphides, sulpharsenides, sulphantimonides, and selenides. Alunite is exceptionally an important constituent, and in the particular case dealt with it is the chief constituent. Less important occurrences of alunite are met with in other parts of the United States, notably in Colorado and Nevada. Among the Rosita Hills of Colorado alunite occurs as a granite-like rock associated with quartz, but these rocks contain only about 2·4 per cent. of potash.

Outside the United States, perhaps the most important occurrences are those of Bullah Delah, in New South Wales, and Tolfa, near Civita Vecchia, in Italy.

At Bullah Delah, N.S.W., there is a narrow range of hills three miles long, with a maximum altitude of 900 ft., which for a mile or more of its length is composed almost entirely of the mineral alunite; there are several varieties of the mineral at this locality, the purest being very compact and light pink in colour, and containing 9·5 per cent. of potash. The Bullah Delah deposit has been worked for many years as a source of alum. (See "Alunite or Alumstone," *Min. Res. N.S.W.*, by E. F. Pittman, 1901, p. 415.)

The Tolfa deposits in Italy are vein deposits, and have been worked for four centuries. (See "La métallogénie de l'Italie," by L. de Launay; *Compt. Rend.*, 10*th Internat. Geol. Cong.*, *Mexico*, 1906, Pt. 1, p. 679.)

Copper Ore.—*Mem.* No. 21, 1912, *Geol. Surv. Branch, Dept. of Mines, Canada*, gives an account of "The Geology and Ore Deposits of Phœnix Boundary District, British Columbia," by O. E. Le Roy.

Phœnix is the most important copper camp in Canada. Up to July 1, 1910, the mines have produced and shipped over 7,000,000 tons of ore. The geological formations of the locality include the Knob Hill group, consisting of a complex of various rocks of igneous origin and a minor development of sediments including limestone; the Knob Hill group is succeeded by the Brooklyn formation, which consists of crystalline limestones, tuffs, and argillites. These two formations are of Palæozoic and possibly of Carboniferous age. There are a few small intrusions of syenite and syenite porphyry, which are supposed to be connected with the more extensive granodiorite intrusions, of possibly Jurassic age, widely developed elsewhere in the district.

The ore-bodies occur in a mineralised zone which represents a portion of the Brooklyn limestone replaced by epidote and garnet. They range in size from lenses about 100 ft. long and 20 ft. thick to extensive masses like the main ore-body of the Knob Hill-Ironside mine, which is about 2,500 ft. long, 900 ft. wide, and has a maximum thickness of 125 ft.

The ore is uniform throughout. It consists of finely disseminated chalcopyrite, with pyrite and hæmatite, in a gangue composed chiefly of epidote, garnet, quartz, calcite, and chlorite. Magnetite occurs in distinct masses, both in and along the borders of the main ore-bodies. The chalcopyrite carries all the copper, gold, and silver values, the average ore containing from 1·2 to 1·6 per cent. of copper, and gold and silver to the value of about $1 per ton. The ore-bodies are supposed to have been formed by metasomatic replacement of the limestone under the influence of solutions arising from the granodiorite intrusions.

Diatomite.—In "Diatomaceous Earth and its Occurrence in Victoria" (*Bull.* No. 26, 1912, *Geol. Surv.*, *Victoria*), D. J. Mahony gives a list of the localities in Victoria where diatomite is known to occur, and describes the deposits. The better qualities of diatomite are almost always associated with basalt belonging to the Newer Volcanic series, which is probably all of Pliocene age or younger. The deposits sometimes rest on the surface of older sedimentary rocks, and are covered with basalt; they may be interbedded with basalt flows; or they may fill depressions in the surface of the basalt.

The chief deposits are those at Lillicur, where diatomite has been worked for some years: practically the whole of the diatomite mined in Victoria comes from this locality. One deposit at Lillicur completely fills a basin-shaped hollow in the basalt, the maximum depth being 17½ ft. It covers an area of over 4½ acres. This hollow is estimated to carry over 60,000 tons of diatomite. The basalt in which it occurs is highly vesicular. The deposit is horizontally stratified, and of snowy whiteness. Occasionally, cracks filled with clay or pale yellow opal are found in the beds. In another deposit mining operations are being carried on by means of shallow shafts, from which drives and cross-cuts are put out into the deposit, which is capped by basalt.

The output of diatomite from the Lillicur deposits during recent years has been as follows: 800 tons, valued at £2,400, in 1909; 500 tons, valued at £2,000, in 1910; and 400 tons, valued at £1,600, during 1911. The total quantity that has been mined in Victoria amounts to about 3,900 tons, valued at £15,900.

Gold.—*Mem.* No. 12, 1912, *Geol. Surv.*, *Victoria*, is a "List of Nuggets found in Victoria." Nearly all the Victorian nuggets have been obtained from the area between Ballarat on the south, Wedderburn on the north, Tarnagulla on the east, and Ararat on the west.

The number of nuggets in the list is 1,327. At the head of the list is "The Welcome Stranger Nugget," with a net weight of 2,284 oz. 16 dwt. 22 gr. There are 11 others with a weight exceeding 1,000 oz. Nos. 13 to 48 range in weight from 1,000 oz. to 500 oz.; Nos. 49 to 396 range from 500 oz. to 100 oz.; and Nos. 397 to 1,327 range between 100 oz. and 20 oz.

In a preface to this list, E. J. Dunn, the late Director of the Survey, deals with the origin of nuggets.

Nuggets frequently contain quartz, and are sometimes embedded in that mineral. Mr. Dunn states that where the gold and associated quartz are in contact the quartz is always angular; it is in just the same condition in which it occurs in the reefs, and is not rounded and water-worn as it would be if the gold had grown round it in alluvial deposits. Another mineral frequently associated with the nuggets is limonite, which has resulted from the oxidation of iron pyrites that existed originally in the lode. The nuggets are also frequently stained with ferruginous clay and oxide of manganese. Their surfaces invariably show much scratching and rounding, a fact inconsistent with the view that they have grown in the gravels. Mr. Dunn concludes that, though there is ample proof of the presence of gold in drift waters, there is no evidence that accretion of gold occurs so as to enlarge the size of the nuggets in the drifts.

Mica.—"Mica, its Occurrence, Exploitation, and Uses," by H. S. de Schmid (*Mines Branch, Dept. of Mines, Canada*, 1912), is a second edition, re-written and greatly enlarged, of a monograph on Canadian mica. The first edition, by F. Cirkel, was issued in 1905, and contained 148 pages. The second edition has grown to 411 pages, and is profusely illustrated with maps and plates. Part I. gives a list of the principal mica deposits which have so far been exploited, together with an account of the work done at the various mines. Part II. deals with the mineralogy of mica, its modes of occurrence, the minerals associated with it, its uses and preparation for the market. Part III. gives an abstract of mining laws.

The demand for mica has suffered much fluctuation during recent years, reaching its minimum in 1907–8. This has led to a severe restriction of mining operations, and large numbers of properties are still closed down, the owners not considering the present market profitable enough to warrant re-opening.

The operations of mica-winning in Canada are those of surface quarrying rather than of true mining. Many operators extract the mica in sight at the surface and then abandon the place without further development. In some cases, however, the deposits have been followed by means of shafts and drifts to depths of 100 ft. or more, and the results obtained have shown that the mica continues in depth, though the pockety nature of the occurrences will always prove a serious obstacle in exploitation.

Trona.—The *Rec. Geol. Surv., India* (1912, **41**, Part IV.), gives an account of the geology of the Lonar Lake by T. H. D. La Touche, with a note on the Lonar soda deposit by W. A. K. Christie. The Lonar Lake is in the Buldana District of Berar, in the Central Provinces of India. It lies in an almost circular hollow in the basaltic lavas of the district, and is surrounded, except on the north and north-east, by a raised rim of basalt. The hollow is 1¼ miles in diameter, measured from crest to crest of the rim, and about 300 ft. deep. The lake has no outlet, and its waters are charged with alkali salts. During the visit of Messrs. La Touche and Christie in March 1910, the lake was almost at its lowest, and was in no place more than 2 ft. deep.

Crude soda has been obtained from the lake for centuries. At the present time the method adopted to obtain the salts is as follows: When the lake water has receded by evaporation, a whitish incrustation known as "bhuski" is left on the shores. This contains algæ and other organic impurity, and is at present unsaleable. Wooden stakes are fixed in the bottom of the lake at intervals determined by experience; when the water has evaporated so far as to leave the outermost stake on dry land, the first layer of crystals, known as "papri," is collected by hand from the bottom of the lake. This generally takes place about May, when the lake is about 6 in. deep. When the brine has retreated as far as the next stake, "khuppal" is similarly collected, and "dulla" after a further retrogression. The deposits formed after that are called "nimak dulla" or "dulla nimak." The following analyses, taken from a report by F. J. Plymen (*Ind. Trade Journ.*, 1909, **14**, 229), show the percentage composition of the various products:

		Dulla.	Khuppal.	Dulla nimak.	Nimak dulla.	Papri.	Bhuski.
Carbon dioxide	CO_2 as carbonate .	19·47	10·00	13·72	4·84	9·62	13·58
" "	CO_2 as bicarbonate	17·38	9·52	13·72	4·49	9·02	14·42
Chlorine	Cl . . .	trace	22·73	14·72	43·25	25·48	2·03
Soda	Na_2O . . .	33·65	35·17	34·42	44·54	33·36	26·15
Potash	K_2O . . .	7·14	6·88	9·95	4·28	10·29	5·07
Silica	SiO_2 . . .	0·17	0·40	0·33	0·26	0·05	0·30
Ferric oxide and alumina	$Fe_2O_3 + Al_2O_3$.	0·46	1·21	0·64	0·65	1·47	4·58
Lime	CaO . . .	0·13	0·24	0·24	0·16	0·26	1·35
Magnesia	MgO . . .	0·09	0·22	0·21	0·22	0·40	0·39
Sulphur trioxide	SO_3 . . .	none	0·70	0·10	0·08	0·87	0·21
Water and organic matter . . .		20·90	16·03	15·30	6·46	14·71	24·46
Insoluble residue		2·07	5·49	2·57	2·21	5·01	20·83

The analyses show that the salts deposited by the lake waters are partly sodium chloride and partly trona (Na_2CO_3, $NaHCO_3$ $2H_2O$).

These salts appear to owe their origin to slow concentration from the waters of the streams entering the lake. The unweathered trap rock of the neighbourhood contains all the necessary ingredients; and the water of the spring feeding the main stream contained the equivalent of 0·30 gram of sodium carbonate per litre. It is considered probable, however, that the chlorides are derived to some extent from the sea, and are carried in the strong westerly winds that blow steadily from the coast towards Lonar.

NOTICES OF RECENT LITERATURE

New Books

The Empire of India. By Sir Bampfylde Fuller K.C.S.I., C.I.E. Pp. xi + 394, with coloured map and full-page plate illustrations. Demy 8vo. (London: Sir Isaac Pitman & Sons, 1913.) Price *7s. 6d.* net; post free, United Kingdom *7s. 11d.*, abroad *8s. 3d.*

The number of books published at the present time concerning the British possessions and dependencies overseas indicates the public interest that is taken in the various countries that comprise the British Empire. Not the least important of these works are the volumes comprising the "All Red" Series, of which this is the sixth instalment.

Sir B. Fuller's long service as an Indian official, and especially his experience as Lieutenant-Governor of Eastern Bengal and Assam, under Lord Curzon's administration, brought him into direct contact with the various peoples of India, and this eminently qualifies him to discuss the numerous problems and difficulties of Indian administration.

The book gives in a concise and readable form an account of India as it exists at the present day, and describes the country, the people, the Government, and India's future prospects. The last two sections are perhaps the most interesting in the book, and contain much that is of topical interest, such subjects as education, taxation, the influence of British rule, and the political aspirations of the Indian reformers, being fully dealt with. With reference to the last-named subject, the author states, "British authority must be maintained, not only in the interests of British manufacturers and officials, but in the interests of India's peace and progress. And it has been an accepted function of British rule to foster progress, to encourage the adoption of Western ideas, and to provide such opportunities as it can for their exercise. Rooted in these ideas are aspirations for power in politics, and these are naturally entertained by Indians who have sat at the feet of Western teachers. To meet them without risking the stability of the Government is a problem of ever-increasing complexity."

CAMP AND TRAMP IN AFRICAN WILDS. By E. Torday. Pp. 316, 8vo. (London: Seeley, Service & Co., Ltd., 1913.) Price 16*s.* net; post free, United Kingdom 16*s.* 5*d.*, abroad 16*s.* 10*d.*

This is a narrative of experiences in the Congo during the period 1900 to 1907, the whole of which time the author spent in that region, with the exception of a short interval of a few months.

The author confines his attention to giving a straightforward account of his own tours, and of the habits and characteristics of the various native tribes with which he came into contact. He has a great many observations to put on record, and these are described in a thoroughly interesting way, so that the book makes enjoyable reading. It is well illustrated by reproductions from photographs of typical natives and native scenes, and contains a good map of the Congo, in which the routes followed are shown.

QUEBEC: THE LAURENTIAN PROVINCE. By Beckles Willson. Pp. xii + 272, 8vo. (London: Constable & Co., Ltd., 1913.) Price 10*s.* 6*d.* net; post free, United Kingdom 10*s.* 10*d.*, abroad 11*s.* 3*d.*

Though Quebec, and especially its French-speaking population, receives a considerable amount of attention in ephemeral political literature relating to Canada, there is a tendency in this country to regard the newer provinces in the west and far west as perhaps the most interesting parts of the Dominion, possibly because the material resources of these areas are so constantly and vigorously impressed on the attention of the mother-country.

A tour in the Dominion is certainly the best method of correcting such an impression, but for the millions of Englishmen who are unable to visit even the nearest of the Overseas Dominions, Mr. Willson's various books dealing with the eastern provinces of Canada will do much to enable them to view the various parts of the Dominion in more correct perspective. Quebec, as Mr. Willson describes it, is a prosperous province in which industry and agriculture are vigorously prosecuted, but in which the banalities that so often accompany rapid material success in new countries have been largely avoided by the good sense of its people.

A large part of the book is devoted to descriptions of the two chief cities, Quebec and Montreal, and of typical parts of the province. Room is, however, also found for chapters on the influence of the Roman Catholic Church on the life of the province, on the use of the French language, the relations of the French Canadians to their compatriots, and on the development of literature and art in the province.

The volume is fully illustrated by reproductions from photographs, and contains a useful map of the province.

GREATER ROME AND GREATER BRITAIN. By Sir C. P. Lucas, K.C.B., K.C.M.G. Pp. 184, 8vo. (Oxford: Clarendon Press, 1912.) Price 3*s.* 6*d.* net; post free, United Kingdom 3*s.* 10*d.*, abroad 4*s.*

A book on the philosophy of Empire, in which the Roman and the British systems are contrasted—or, rather, seen for the most part under antithetical aspects—comes as a welcome contribution from the pen of Sir Charles Lucas.

In their dominant characteristics, the Roman Empire was a military Empire; the British Empire is a naval Empire—and much else besides. The Roman Empire was one, and practically undivided: Roman citizenship was a very real thing. The marvel is, not that the Empire fell—for want of competition, perhaps—but that it endured beyond the centuries of its unrivalled power. The British Empire—divided, yet united by sea power—embraces, like the Roman, a sphere of rule; and also, within its overseas development, a sphere of settlement. The most marked antithesis between the British and Roman systems is presented in Austral Britain; the only analogy, perhaps, in British India. "A nearer approach to British colonization," the author states (p. 22), "is to be found in the history of Greece than in that of Rome." But, in fact, there is "no parallel to it in the history of the world." That is what makes the subject so interesting, and so deserving of special study.

In the internal relations of the British Empire, the analogy of the family—Mother-Country and Daughter States, or Self-Governing Dominions—is faithfully followed; but the author somewhat transgresses the sanction of geographical science by insisting too rigidly on the Empire being really two Empires in one: the sphere of rule (the Dependencies) and the sphere of settlement (Self-Governing Dominions). India is, indeed, in the strictest sense, a Dependency of the Crown—and never can become a true colony of settlement; but all else, outside the temperate regions, may be included under appanages of Empire, or colonies of exploitation, in which British rule is mainly conspicuous.

The bulk of the book is filled with a searching, if somewhat cursory, analysis of the foundations of Empire under the broad philosophical categories of Space, Youth, Science; the Individual, the Company, and the State; Class, Colour, and Race; the Natural and the Artificial. All this is delightful reading. Though we cannot quite follow the author in his empirical treatment of "The two Empires," we are wholly with him in the concluding chapter on "The British Instinct and the Law of National Life"—the British instinct standing for "the instinct of wise opportunism: the one and only safe guide to sound relations between the Self-Governing Dominions and the Mother-Country."

We are grateful to Sir Charles Lucas for giving us this aftermath of his scholarly researches in the historical geography of the British Empire.

SIAM AND ITS PRODUCTIONS, ARTS, AND MANUFACTURES. By Colonel G. E. Gerini. Pp. lxiv + 339, 8vo. (Hertford: Austin & Sons, Ltd., 1912.)

This is an English edition, revised and brought up to date, of the handbook prepared for the Siam Section of the Turin Exhibition held in 1911. It gives a great deal of information regarding Siam, its people, arts, productions, and manufactures, and should serve the purpose of making English business men better acquainted with the resources of this interesting Far Eastern country.

WELTWIRTSCHAFTLICHES ARCHIV. Zeitschrift für Allgemeine und Spezielle Weltwirtschaftslehre, 1 Band, Heft 1. Pp. 248 + 92 + 35, Med. 8vo. (Jena: Gustav Fischer, 1913.) Price 10*s.*; post free, United Kingdom 10*s.* 4*d.*, abroad 10*s.* 6*d.*

This new journal is a quarterly review of economics, edited by Dr. Bernhard Harms, of Kiel University, and is an example of the literature produced by the school of "world economists" that has arisen in Germany in the last few years, with its centre in Kiel, where an Institute of Sea Transport and World Economics has been founded in connection with the University.

Each number of this review will consist of three parts, viz. articles by experts, reviews of literature, and a chronicle of recent events of interest to economists and men of business. The special articles in this number include several likely to be of great interest in this country. Dr. Harms discusses world economics and the study of this new science. Dr. Thiess, of Dantzig, deals with the railway gauges of the world and the desirability of a uniform gauge. Dr. Liefmann, of Freiburg, gives an interesting account of the international organisation of the Frankfort business in metals. Other useful articles are on sea insurance, by Herr Fitger, of Bremen, and on the international effects of the new Italian insurance monopoly law, by Dr. Rocca, of Rome.

The notices of recent literature form perhaps the most remarkable portion of this new review. This part appears to aim at giving at least a short summary of the contents of each publication on economics issued during the preceding quarter in any part of the world. The more important books are reviewed in detail by well-known authorities on the subjects of which they treat, whilst the contents of less important works, or of publications only remotely connected with economics, are summarised.

The third part is a chronicle of recent information on various branches of economics, *e.g.* sea-transport, railways, posts and telegraphs, telephones, international trade and trade statistics, international finance, emigration, banking statistics, etc.

The great majority of the contributors are, of course, German, but the co-operation of economists and experts in this country, France, the United States, and elsewhere, has been secured, and when the publication has got thoroughly started it will no doubt present each quarter a most interesting account of economic developments in all parts of the world. It should be of special value in this country, where, if world economics has not been made the subject of academic study, its practical side is at least well understood.

VOORDRACHTEN OVER KOLONIALE ONDERWERPEN. Gehouden ter Gelegenheid van de Koloniale Landbouwtentoonstelling te Deventer. Met 54 Illustraties naar Foto's. Pp. 201, Roy. 8vo. (Deventer: Æ. E. Kluwer, 1913.) Price 3·50 florins (5*s.* 10*d.*); post free, United Kingdom 6*s.* 2*d.*, abroad 6*s.* 5*d.*

In May 1912, a small but interesting exhibition of raw materials from the Dutch Colonies was held at Deventer in Holland. During the exhibition a series of lectures was delivered dealing with various aspects of tropical agriculture, and these lectures have now been reproduced in this volume. There are thirteen lectures in all, eight in Dutch, one in English, three in French, and one in German, so that a perusal of the volume calls for a certain amount of linguistic ability. The subjects are well chosen, with a view to giving a general idea of some of the principal problems of tropical agriculture at the present time, and they include the following: Irrigation in Java, the Improvement of Java Tea, Technique of the Java Sugar Industry, Cultivation of Cinchona and the Manufacture of Quinine, Rubber, Exploitation of Rubber Trees in Africa, Agricultural Productions in French Tropical Colonies, Preparation of Cocoa, and the Chemical Composition of Tropical Soils. Most of the lectures are illustrated by reproductions from photographs.

LES TEXTILES VÉGÉTAUX. By J. Beauverie, with preface by H. Lecomte. Pp. xiii + 730, Roy. 8vo. (Paris: Gauthier-Villars, 1913). Price 18 fr. (14*s.* 6*d.*); post free, United Kingdom 15*s.*, abroad 15*s.* 9*d.*

The information hitherto published on the cultivation, preparation, and utilisation of vegetable fibres is scattered over so wide a range of literature that the compilation of a general treatise on the subject was sorely needed. The present work will therefore be welcomed as supplying this want, and will be of much service to those engaged in cultivating fibres or manufacturing textiles, as well as to merchants and others interested in these materials.

In the first part of the book, the anatomical origin of the various fibres is discussed, their physical and chemical characters are described, the general principles of the retting process are explained, and a classification is provided.

In the second part, of which nearly one-third is devoted to cotton, the fibres are dealt with individually in the order usually adopted in systematic botany. In each case, the plant is described, an outline of the methods of cultivation is given, and reference is made to the diseases and pests by which it is liable to be attacked. Details are given of the processes of extraction and preparation, statistics are furnished to indicate the relative importance of the product in the various parts of the world, and recent prices are recorded.

The work is well illustrated and contains a good index, and a useful, classified bibliography.

THE TESTING OF WOOD PULP. A Practical Handbook for the Pulp and Paper Trades. By Messrs. Sindall and Bacon. Pp. 148, Demy 8vo. (London: Marchant Singer & Co., 1912.) Price 5*s.* net; post free, United Kingdom 5*s.* 3*d.*, abroad 5*s.* 4*d.*

During the last forty years or so, the utilisation of wood pulp for the manufacture of paper has assumed enormous proportions both in the United Kingdom and on the Continent. It is of the utmost importance to papermakers that the consignments of wood pulp which they receive should be submitted to examination in order to ensure that they do not contain an excess of moisture and that the material is of the quality required for their purposes. The need of a simple handbook on the methods of testing wood pulp has led the authors to prepare the present treatise, which embodies the results of the principal workers in this sphere and describes the methods now employed in various countries.

The book is divided into two sections, the first dealing with the withdrawal of representative samples from the bulk and the estimation of moisture in them, and the second relating to the mode of ascertaining the bleaching qualities of the pulp. In an appendix, a short account is given of the chemistry of the bleaching process and the preparation and behaviour of bleaching liquors. The subject-matter is well arranged, and numerous illustrations and useful tables are provided. The book will doubtless be very welcome to paper-mill chemists and will also be of service to manufacturers of wood pulp.

RESEARCHES ON CELLULOSE.—III (1905–1910). By C. F. Cross and E. J. Bevan. Pp. x + 173, 8vo. (London: Longmans, Green & Co., 1912.) Price *7s. 6d.* net; post free, United Kingdom *7s. 10d.*, abroad *8s.*

In two earlier volumes the authors have dealt with the work on cellulose accomplished during 1895–1900 and 1900–1905 respectively. The present volume gives an account of the investigations carried out during 1905–1910. The researches are divided into several classes, including those dealing with normal cellulose and its constitution, the cellulose esters, the lignocelluloses, and technical developments in the various industries connected with cellulose, such as the manufacture of textiles, paper, artificial silk, and celluloid. Summaries of the various researches are given and discussed. These memoirs serve a useful purpose in providing a ready means of obtaining knowledge of recent progress in this branch of chemistry, and are consequently of considerable value to those interested in the subject.

FATTY FOODS: THEIR PRACTICAL EXAMINATION. By E. R. Bolton and Cecil Revis. Pp. x + 371, 8vo. (London: J. & A. Churchill, 1913.) Price *10s. 6d.* net; post free, United Kingdom *10s. 11d.*, abroad *11s. 2d.*

This work is primarily intended for the use of chemists engaged in the analysis and investigation of oils and fats. The first part of the book is devoted to the description of analytical methods, only the more modern and reliable methods being included, while the consideration of a number of typical cases of adulteration and of problems for investigation is a particularly valuable feature. Following this are descriptions of all the common and of some of the less common edible oils and fats. It is, of course, impossible to give very full details in a work of this scope, but a large amount of useful information is given; the illustrations of oil-seeds included in this section are, however, very poor, and in some cases misleading (*e.g.* those of ground nuts and shea kernels). In the latter part of the book the examination of cocoa, chocolate, feeding stuffs, and milk is dealt with, and in connection with the examination of cocoa a number of photomicrographs of starches are given; these are too small to be of much use, and are also not very well reproduced.

On the whole the work is clear, devoid of unnecessary detail, and well arranged, and will form a valuable reference book for the analyst and all interested in edible oils and fats.

BEURRES ET GRAISSES ANIMALES. By A. Bruno. Pp. 300, Crown 8vo. (Paris et Liège: Ch. Béranger, 1912.) Price 6 fr. (*5s.*); post free, United Kingdom *5s. 4d.*, abroad *5s. 5d.*

This volume deals chiefly with the methods of examination of butter, margarine, lard, etc., and is very similar in scope and arrangement to a previous book of the same series dealing with vegetable fats, and already reviewed in this BULLETIN (1912, **10**, 523). It will form a valuable addition to the library of the analyst, and will also be of interest to all who are in any way connected with the trade in these important articles of food.

INJURIOUS INSECTS: HOW TO RECOGNISE AND CONTROL THEM. By Walter C. O'Kane. Pp. 414. (New York: The Macmillan Company, 1912.) Price 8*s.* 6*d.* net; post free, United Kingdom 8*s.* 11*d.*, abroad 9*s.* 5*d.*

This book, while primarily concerned with the more important insect pests affecting the crops of the United States, should prove very useful to students of economic entomology in other countries. The subject is treated in a semi-popular style in so far as the term indicates an absence of abundant technical nomenclature, but the work is free from that annoying inutility which not infrequently accompanies the popular treatment of this branch of agricultural science. The book is divided into three parts. Part I. gives an interesting account of the structure, habits, and classification of insects, while Part II. is concerned with the practical methods adopted for the control of insect pests, and affords the usual information in regard to insecticides and the apparatus employed in their application. Part III. forms the bulk of the book, and consists of a systematic account of a large number of insect pests, an important feature being the fine series of photographs (some 600 are found in the book) which illustrates the text. The pests are considered in three groups, viz. (1) insects attacking garden and field crops; (2) those affecting orchard and small fruits; and (3) household pests infesting stored products and domestic animals. Identification of a pest is further facilitated by a practical sub-grouping according to the actual place in which the pest is found at work, *e.g.* in the soil, in the tree trunk, in the leaf and fruit. There is a very full index, occupying nearly twenty-four pages. A handbook of this character should be strongly bound, and weigh less than 2¼ lb.

INSECTICIDES, FUNGICIDES, AND WEEDKILLERS. A Practical Manual on the Diseases of Plants and their Remedies, for the use of Manufacturing Chemists, Agriculturists, Arboriculturists, and Horticulturists. By E. Bourcart, D.Sc. Translated from the French, revised and adapted to British standards and practice by Donald Grant. Pp. xxxv + 431, Demy 8vo. (London: Scott, Greenwood & Son, 1913.) Price 12*s.* 6*d.* net; post free, United Kingdom 12*s.* 11*d.*, abroad 13*s.* 4*d.*

This work contains an account of the various remedies which have been employed for the treatment and prevention of plant diseases. In an introductory chapter, the various causes of disease are briefly reviewed, and general curative and prophylactic measures are discussed. In the subsequent chapters, the various agents used as insecticides, fungicides, or weedkillers are considered in turn, the inorganic substances being dealt with first.

Each chemical agent is made the subject of a separate section, and an account is given of its mode of preparation, its properties, and its application in the prevention or cure of plant diseases. Numerous recipes are provided for the preparation of sprays, washes, weedkillers, etc., and instructions are given as to the manner in which they should be applied. The paragraphs on the preparation of the various chemicals do not appear to add to the value of the book, and might well be dispensed with, as the information afforded is not likely to be of any utility to the various classes of readers mentioned in the title. In most cases the particulars supplied are quite inadequate, and in many instances misleading.

The scope of the work is almost entirely restricted to plants of the temperate zone, and its value is thereby greatly limited. If the diseases of tropical economic plants, such as cocoa, coffee, cotton, rubber, and tobacco, were included, the book would be very useful to planters in the Colonies.

A glossary is appended of the principal diseases of plants and of the parasites or pests by which they are occasioned. An outline of the life-history and habits of each pest is furnished in order to afford an indication of the periods of its existence in which it is most vulnerable, and therefore most easily checked. An index, numerous tables, and several illustrations are provided.

PRACTICAL AGRICULTURAL CHEMISTRY. By S. J. M. Auld, D.Sc., Ph.D., and D. R. Edwardes-Ker, B.A., B.Sc. Pp. xxiv + 243, Crown 8vo. (London: John Murray, 1913.) Price 5*s.* net; post free, United Kingdom 5*s.* 4*d.*, abroad 5*s.* 6*d.*

The scope of this practical handbook, which is intended for agricultural students, is wide, embracing the chemical examination of foods, water, soils, resins, alkaloids, glucosides, soaps, tanning materials, essential oils, fats, manures, fibrous wastes, oil-cakes, cereals, roots, and green fodders. But in spite of the mass of information in the book, it is clearly written, and the experiments are lucidly described. Students should be grateful for having been spared the task of studying numerous voluminous treatises in order to gain what this volume so tersely presents, an introductory knowledge of that very wide subject—agricultural chemistry.

The book is divided into six sections, the first of which deals with the ultimate and proximate constituents of plants and their determination, including experiments to demonstrate cyanogenesis and photo-synthesis; section ii. is devoted to the chemical and physical properties and the chemical and mechanical analysis of soil; section iii. treats of the examination of manures and fertilisers; whilst sections iv. and v. deal with feeding stuffs and dairy products respectively. The last section of the book describes the examination of waters and soap.

In each branch of the subject many experiments are described purely to demonstrate to the student a point at issue, but at the same time the book does not neglect processes which are accepted as standard methods by analysts.

There are thirty-one illustrations of apparatus in the book, partly diagrams and partly reproductions from photographs. They should prove of real value to the student in practice, but the same cannot be said of the photomicrographs of starch granules in Fig. 9.

THE MINERALOGY OF THE RARER METALS. By E. Cahen and W. O. Wootton, with a foreword by F. W. Harbord. Pp. xxviii + 211, Foolscap 8vo. (London: C. Griffin & Co., Ltd., 1912.) Price 6*s.* net; post free, United Kingdom 6*s.* 2*d.*; abroad 6*s.* 3*d.*

This is a pocket-book, dealing with the minerals which contain what are styled the rarer metals. It is intended for use by prospectors. The metals are arranged alphabetically. In each case are given the properties, preparation, industrial application, and commercial value; and this is followed by an account of the minerals containing the metal. Only the simpler characters of the minerals are given. There is a small section on methods of analysis, which might with great advantage have been made fuller.

Much care has evidently been bestowed on the work of compilation, but the results, especially as regards commercial information, leave much to be desired. The term "commercial ores," which is used throughout the book, is redundant, and under this head much misleading information is given. Thus on p. 23 it is stated that monazite, cerite, allanite, and gadolinite are "commercial ores" of cerium. Gadolinite contains little or no cerium, and is certainly not a cerium ore. The statement also implies that cerite and allanite are in demand as a source of cerium, which is not the case. Monazite is in demand not as a source of cerium, but of thorium, and is paid for on the basis of its thorium contents only.

In addition, it is asserted that "monazite 95 per cent. pure containing 5 per cent. ThO_2 is worth £54 per ton. Monazite 95 per cent. pure containing 3 per cent. ThO_2 is worth £25 per ton," which is not the case at the present time. The values of rare minerals are much too uncertain to be worth quoting in a publication such as this.

On p. 159 zircon is mentioned as the "commercial ore" of zirconium. Nothing is said under baddeleyite of the importance of this mineral as a source of zirconia, and the 106 tons of "zircon" stated on p. 159 to have been exported from Brazil was probably baddeleyite, and not zircon (see this BULLETIN, p. 147).

It seems rather singular that the authors should raise such minerals as "auerlite" and "naëgite" to the dignity of distinct species, whilst they regard ilmenorutile and strüverite as varieties of rutile. It is stated, moreover, that strüverite is orthorhombic (p. 116).

Among various other matters which call for criticism, it should be mentioned that there is an unnecessary amount of blank paper in the book; and the section dealing with the geographical distribution of rare minerals is very incomplete.

The book is handy in size, well printed, and daintily bound, but has no illustrations.

SOUTH AFRICAN GEOLOGY. By E. H. L. Schwarz. Pp. vi + 200, Crown 8vo. (London: Blackie & Son, Ltd., 1912.) Price 3*s.* 6*d.* net; post free, United Kingdom 3*s.* 9*d.*, abroad 3*s.* 11*d.*

This is an elementary text-book, in which the principles of geology are explained with reference to South African features.

The subject-matter is divided into four sections, viz. descriptive geology (60 pages); dynamic geology and tectonic geology (26 pages each); and stratigraphical geology (77 pages). As one might expect, the most valuable of these sections is the last, more than half of which is devoted to Cape Province, the remainder dealing chiefly with the Transvaal. A few pages are given to the stratigraphy of Natal, Damaraland, Rhodesia, and Central Africa.

The book is illustrated, some of the illustrations being fairly good, others rather crude. Cruder still, however, are many of the statements made in various parts of the book. Of these a few examples may be quoted:

"A cup of tea consists of water on the one hand, and tea, sugar, and the substance of milk on the other. If we add enough sugar the water will practically disappear, and a sticky mass will be produced quite unlike the original tea concoction. In rocks silica takes the place of water, and is called the acid; the other substances, representing the sugar, etc., are called bases, and consist of alumina, iron, lime, potash, and soda" (p. 59).

"The essential mineral [of dolerite] is one of the bases, usually iron, in the form of magnetite or titaniferous magnetite, called ilmenite, the carbon of the Kimberley diamond diggers" (p. 61).

"Sand may be consolidated into sandstone merely by pressure, or cement may be added by precipitation from water; and this cement, which may be compounds of iron, calcite, or silica, binds the grains into a firm rock, usually in such cases called quartzite" (p. 64).

"Corundum, or emery, is deposited in the same way [by pneumatolitic action], but not in the tin-wolfram series" (p. 119).

As regards the author's views on the origin of the earth, and the nature and origin of igneous intrusions, a beginner's text-book is scarcely the proper place for them. It is inadvisable to puzzle a beginner with recondite theories concerning the broad problems of geology. Before he can think profitably about these things, the student needs to have his mind furnished with sound data.

Although the book has some defects (there is no index), it has many good features, and it will be not unwelcome among students working in South Africa. When a second edition is called for, as it doubtless will be, Professor Schwarz will probably make many needful improvements and thus increase its usefulness.

GUIDE SCIENTIFIQUE DU GÉOGRAPHE-EXPLORATEUR. By P. Crépin de Beauregard. Pp. 250. With two star maps and numerous diagrams in the text. Imp. 8vo. (Paris: Gauthier-Villars, 1912.) Price 10 fr.; post free, United Kingdom 8*s.* 4*d.*, abroad 8*s.* 8*d.*

The scope of this work is by no means so extensive as the title would imply. It is in fact a text-book of surveying for those engaged in geographical exploration and gives full directions for carrying out a provisional but systematic survey of a little-known region. In form it is an elementary text-book of the subject, but it is doubtful whether it would supply sufficient explanation and information to be intelligible to the beginner. To those, however, who possess already some knowledge of the subject it will be of the greatest interest and use, for they will find the whole subject dealt with on lines which, in many cases, differ considerably from those followed in English-speaking countries. The mathematical demonstrations, too, are frequently characterised by novelty and simplicity. The volume includes full instructions for the use of theodolites and chronometers, astronomical determinations of position and azimuth, elementary geodesy, including levelling and methods of projection, as well as practical hints for surveyors.

There are two tables, one for use in circummeridian observations for latitude and the other to be employed in the calculation of latitudes and longitudes, when the ellipsoidal form of the earth's surface is taken into consideration.

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